SAFETY.CAT.COM™

MAINTENANCE INTERVALS

Operation and Maintenance
Manual Excerpt

© 2010 Caterpillar
All Rights Reserved

CATERPILLAR®

CATERPILLAR®

SEBU7147-05
October 2009

Operation and Maintenance Manual

3508, 3512 and 3516 Generator Sets

5PW1-Up (Generator Set)
6WW1-Up (Generator Set)
8TW1-Up (Generator Set)

i03736635

Maintenance Interval Schedule

SMCS Code: 1000; 4450; 7500

Ensure that all safety information, warnings and instructions are read and understood before any operation or any maintenance procedures are performed.

An authorized operator may perform the maintenance items with daily intervals. An authorized operator may perform the maintenance items with intervals of every week. The maintenance that is recommended for all other maintenance intervals must be performed by an authorized service technician or by your Caterpillar dealer.

The user is responsible for the performance of all maintenance which includes the following items: performing all adjustments, using proper lubricants, fluids, and filters, and replacing old components with new components due to normal wear and aging .

Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components.

Before each consecutive interval is performed, all maintenance from the previous intervals must be performed.

Choose the interval that occurs first in order to determine the correct maintenance interval: fuel consumption, service hours, and calendar time . Products that operate in severe operating conditions may require more frequent maintenance.

All of the following will affect the oil change interval: operating conditions, fuel type, oil type, and size of the oil sump . Scheduled oil sampling analyzes used oil in order to determine if the oil change interval is suitable for your specific engine.

In the absence of scheduled oil sampling, replace the engine oil and filters according to the following intervals:

If the engine has a shallow oil sump, change the oil after every 250 service hours.

If the engine has a standard oil sump, change the oil after every 500 service hours.

If the engine has a deep oil sump, change the oil after every 1000 service hours.

Refer to this Operation and Maintenance Manual, “Engine Oil and Filter - Change” in order to determine the oil change interval that is suitable for your specific engine.

To determine the maintenance intervals for the overhauls, refer to this Operation and Maintenance Manual, “Maintenance Recommendations” .

Unless other instructions are provided, perform maintenance and perform repairs under the following conditions:

The starting system is disabled.

The engine is stopped.

The generator does not pose an electrical shock hazard.

The generator is disconnected from the load.

When Required

Battery - Recycle 88
Batteries - Replace 88
Battery or Battery Cable - Disconnect 90
Engine Air Cleaner Element (Dual Element) - Clean/Replace 101
Engine Air Cleaner Element (Single Element) - Clean/Replace 103
Fuel System - Prime 114
Generator Bearing - Lubricate 120
Generator Set - Test 125
Generator Set Alignment - Check 126
Generator Winding - Test 128
Maintenance Recommendations 133
Rotating Rectifier - Check 141
Varistor - Test 145

Daily

Control Panel - Inspect/Test 91
Cooling System Coolant Level - Check 96
Engine Air Cleaner Service Indicator - Inspect ... 106
Engine Air Precleaner - Clean 107
Engine Oil Level - Check 108
Fuel Tank Water and Sediment - Drain 116
Generator Bearing Temperature - Test/Record ... 124
Generator Load - Check 124
Walk-Around Inspection 146

Every Week

Automatic Start/Stop - Inspect 88
Battery Charger - Check 89
Electrical Connections - Check 100
Generator - Inspect 118
Generator Lead - Check 124
Space Heater - Test 142
Stator Winding Temperature - Test 144
Voltage and Frequency - Check 146

Initial 250 Service Hours

Engine Speed/Timing Sensor - Clean/Inspect 112
Engine Valve Lash - Inspect/Adjust 113

Speed Sensor - Clean/Inspect 142

Every 250 Service Hours

Battery Electrolyte Level - Check 89
Belts - Inspect/Adjust/Replace 90
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 97
Engine Oil Sample - Obtain 109
Fan Drive Bearing - Lubricate 113
Hoses and Clamps - Inspect/Replace 132
Radiator - Clean 140

Initial 500 Hours (for New Systems, Refilled Systems, and Converted Systems)

Cooling System Coolant Sample (Level 2) - Obtain 97

Every 500 Service Hours

Cooling System Coolant Sample (Level 1) - Obtain 96
Engine Oil and Filter - Change 110

Every 1000 Service Hours

Engine - Clean 100
Engine Crankcase Breather - Clean 107
Engine Protective Devices - Check 112
Fuel Control Linkage - Check/Lubricate 113
Fuel System Primary Filter - Clean/Inspect/ Replace 114
Fuel System Secondary Filter - Replace 115
Generator Winding Insulation - Test 129

Every 2000 Service Hours

Crankshaft Vibration Damper - Inspect 99
Engine Mounts - Check 108
Engine Valve Lash - Inspect/Adjust 113
Generator Set Vibration - Test/Record 127
Turbocharger - Inspect 144

Every 2000 Service Hours or 6 Months

Generator - Dry 117
Stator Lead - Check 144

Every Year

Cooling System Coolant Sample (Level 2) - Obtain 97
Generator Bearing - Inspect 120

Every 3000 Service Hours or 2 Years

Cooling System Coolant (DEAC) - Change 92

Every 3000 Service Hours or 3 Years

Cooling System Coolant Extender (ELC) - Add 95

Every 6000 Service Hours or 6 Years

Alternator - Inspect 88
Cooling System Coolant (ELC) - Change 94
Cooling System Water Temperature Regulator - Replace 99
Engine Speed/Timing Sensor - Clean/Inspect 112
Speed Sensor - Clean/Inspect 142
Starting Motor - Inspect 144
Water Pump - Inspect 147

Between 7500 and 9000 Service Hours

Overhaul (Top End) 137

Between 15 000 and 18 000 Service Hours

Overhaul (Top End) 137

Between 22 500 and 27 000 Service Hours

Overhaul (Major) 135

Every 228 000 L (60 000 US gal) of Fuel or 6000 Service Hours or 6 Years

Standby Generator Set Maintenance Recommendations 143

Overhaul

Generator Bearing - Replace 123
Overhaul Considerations 138

i02676048

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

i01942284

Automatic Start/Stop - Inspect

SMCS Code: 4462

The generator set must be ready to operate under a load at any time. After performing maintenance on the generator set, inspect the position of the control switches. Ensure the following conditions:

- The starting system is enabled.
- The control switches are in the correct position for automatic starting.
- The switchgear and the automatic transfer switches that are associated with the generator are enabled.

i00993589

Battery - Recycle

SMCS Code: 1401-005; 1401-510; 1401-535; 1401-561; 1401

Always recycle a battery. Never discard a battery.

Always return used batteries to one of the following locations:

- A battery supplier
- An authorized battery collection facility
- Recycling facility

i01041029

Batteries - Replace

SMCS Code: 1401-510

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the ground plane. Disconnect the cable from the NEGATIVE “-” battery terminal.
4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before connecting the cables, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.
8. Connect the cable from the ground plane to the NEGATIVE “-” battery terminal.

i01039758

Battery Charger - Check

SMCS Code: 1401-535

Checking Before Start-Up

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near “0” (zero).

The battery charger must not produce excessive current during start-up. Alternatively, the charger must be automatically disconnected for start-up. If the engine has an alternator, the charger must be automatically disconnected during start-up and during engine operation.

Charging the Battery

⚠ WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

Perform the following procedure to charge the battery:

1. Ensure that the charger is turned OFF.
2. Adjust the voltage of the charger in order to match the voltage of the battery.
3. Connect the POSITIVE “+” lead of the charger to the POSITIVE “+” battery terminal. Connect the NEGATIVE “-” lead of the charger to the NEGATIVE “-” battery terminal.
4. Turn ON the battery charger.

Overcharging of Batteries

Overcharging reduces the service life of batteries. Use a battery charger that will not overcharge the battery. DO NOT charge the battery if the meter of the battery charger is in the RED zone.

Overcharging is indicated by the following symptoms:

- The battery is very warm to the touch.
- A strong odor of acid is present.
- The battery emits smoke or a dense vapor (gas).

Perform one of the following procedures if the battery shows symptoms of overcharging:

- Reduce the rate of charging by a significant amount. Complete the charging at the reduced rate.
- Turn OFF the charger.

Table 25 describes the effects of overcharging on different types of batteries.

Table 25

Effects of Overcharging Batteries	
Type of Battery	**Effect**
Caterpillar General Service Batteries Caterpillar Premium High Output Batteries	All of the battery cells have a low level of electrolyte.
	When the plates of the battery are inspected through the filler holes, the plates may appear to be warped. This is caused by an excessive temperature.
	The battery may not pass a load test.
Caterpillar Maintenance Free Batteries	The battery may not accept a charging current.
	The battery may not pass a load test.

Checking After Stopping

Ensure that the battery charger is connected properly. Observe the meter of the charger. Record the amperage.

i02601752

Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

   If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.

3. Keep the batteries clean.

   Clean the battery case with one of the following cleaning solutions:

   - A mixture of 0.1 kg (0.2 lb) of baking soda and 1 L (1 qt) of clean water
   - A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

   Thoroughly rinse the battery case with clean water.

   Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

i01492654

Battery or Battery Cable - Disconnect

SMCS Code: 1401; 1402-029

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.

2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.

3. Tape the leads in order to help prevent accidental starting.

4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i02667833

Belts - Inspect/Adjust/Replace

SMCS Code: 1357-025; 1357-040; 1357-510

Inspection

Inspect the alternator belt and the fan drive belts for wear and for cracking. Replace the belts if the belts are not in good condition.

Check the belt tension according to the information in the Service Manual, “Specifications”.

Slippage of loose belts can reduce the efficiency of the driven components. Vibration of loose belts can cause unnecessary wear on the following components:

- Belts
- Pulleys
- Bearings

If the belts are too tight, unnecessary stress is placed on the components. This reduces the service life of the components.

Adjusting the Alternator Belt

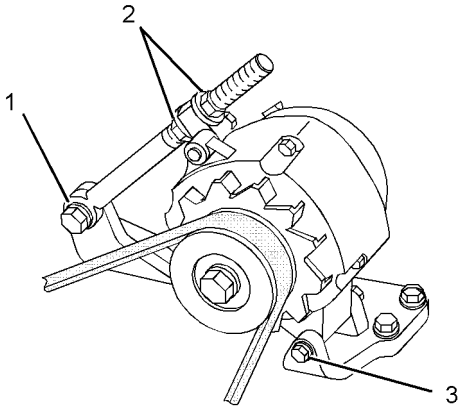


Illustration 63 g01092641

Typical alternator

(1) Mounting bolt
(2) Adjusting nuts
(3) Mounting bolt

1. Remove the drive belt guard.
2. Loosen mounting bolt (1), adjusting nuts (2) and mounting bolt (3).
3. Turn adjusting nuts (2) in order to increase or decrease the drive belt tension.
4. Tighten adjusting nuts (2). Tighten mounting bolt (3). Tighten mounting bolt (1). For the proper torque, see the Service Manual, “Specifications” module.
5. Reinstall the drive belt guard.

If new drive belts are installed, check the drive belt tension again after 30 minutes of engine operation at the rated rpm.

Adjusting the Fan Drive Belt

1. Loosen the mounting bolt for the pulley.
2. Loosen the adjusting nut for the pulley.
3. Move the pulley in order to adjust the belt tension.
4. Tighten the adjusting nut to the proper torque.
5. Tighten the mounting bolt to the proper torque.

For the proper torque specifications, refer to the Service Manual, “Specifications” module.

Replacement

For applications that require multiple drive belts, replace the drive belts in matched sets. Replacing one drive belt of a matched set will cause the new drive belt to carry more load because the older drive belts are stretched. The additional load on the new drive belt could cause the new drive belt to fail.

i03736663

Control Panel - Inspect/Test

SMCS Code: 4490-040; 4490-081; 7451-040; 7451-081

Inspect the condition of the panel. If a component is damaged, ensure that the component is repaired or that the component is replaced. If equipped, ensure that the electronic displays are operating properly. Inspect the wiring for good condition. Ensure that the wiring connections are secure.

Electronic Modular Control Panel 3 (EMCP 3)

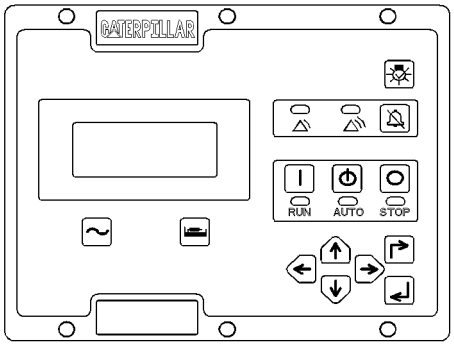


Illustration 64 g01184041

The Lamp Test button is located on the top right side of the electronic control module. Press and hold the Lamp Test button in order to test all of the LED lights and the display screen. The LED lights and the display screen should remain on until the button is released. If any of the components do not pass this test, replace the faulty components before starting the engine.

Switch Panel

The Panel Lights switch should turn on the panel lights. Toggle the switch in order to ensure that the panel lights are working.

Annunciator Panel

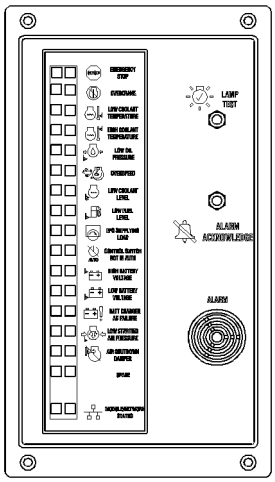


Illustration 65 g01101388

It is possible to test the LED indicators and the horn when the data link is connected and when the data link is not connected. The Lamp Test button is located near the top of the annunciator panel. Test both the horn and the indicators by pressing and holding the Lamp Test button. Replace any faulty components before starting the engine.

i02062150

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-044

Clean the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- The coolant is foaming.
- Oil or fuel has entered the cooling system and the coolant is contaminated.

Drain the Cooling System

1. Stop the engine and allow the engine to cool. Close the water inlet for the separate circuit aftercooler (if equipped). Ensure that the engine will not start when the cooling system is drained.
2. Loosen the radiator filler cap slowly in order to relieve any pressure. Remove the radiator filler cap.

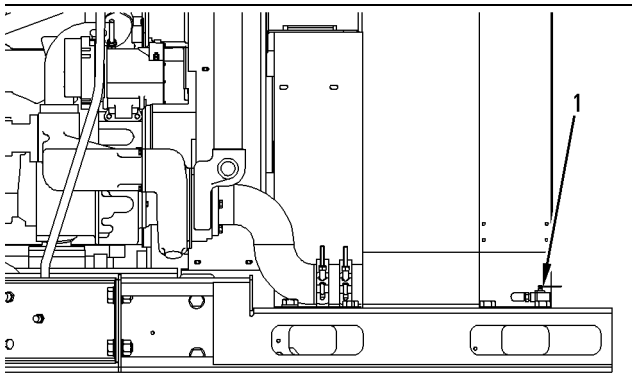


Illustration 66 g00750410

(1) Coolant drain

Note: If the engine has a jacket water heater, drain the coolant from the heater.

3. Open the coolant drain. Allow the coolant to drain.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Dealer Service Tools:

Inside U.S.A.: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL
EAME phone: ++41-22-849 40 56
EAME fax: ++41-22-849 49 29

Clean the Cooling System

NOTICE
Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

1. After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.
2. Close the cooling system drain. Clean the cooling system drain plugs and install the cooling system drain plugs.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the radiator filler cap.

4. Open the water inlet for the separate circuit aftercooler (if equipped). Start the engine. Operate the engine for a minimum of 30 minutes with a coolant temperature of at least 82 °C (180 °F).

5. Stop the engine and allow the engine to cool. Close the water inlet for the separate circuit aftercooler (if equipped). Loosen the radiator filler cap slowly in order to relieve any pressure. Remove the radiator filler cap. Open the coolant drain. Remove the cooling system drain plugs. Allow the water to drain.

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

6. Flush the cooling system with clean water until the water that drains is clean. Close the coolant drain. Clean the cooling system drain plugs and install the cooling system drain plugs. Open the water inlet for the separate circuit aftercooler (if equipped).

Cleaning a Cooling System that has Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be an active flow through the cooling system components.

1. After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.

2. Close the coolant drain. Clean the cooling system drain plugs and install the cooling system drain plugs.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add .5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the radiator filler cap.

4. Open the water inlet for the separate circuit aftercooler (if equipped). Start the engine. Operate the engine for a minimum of 90 minutes with a coolant temperature of at least 82 °C (180 °F).

5. Stop the engine and allow the engine to cool. Close the water inlet for the separate circuit aftercooler (if equipped). Loosen the radiator filler cap slowly in order to relieve any pressure. Remove the radiator filler cap. Open the coolant drain. Remove the cooling system drain plugs. Allow the water to drain.

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

6. Flush the cooling system with clean water until the water that drains is clean. Close the cooling system drain. Clean the cooling system drain plugs and install the cooling system drain plugs.

Fill the Cooling System

Note: For information about the proper coolant to use, and for the capacity of the cooling system, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations”.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with coolant/antifreeze. After filling the cooling system, do not install the radiator filler cap.

2. Open the water inlet for the separate circuit aftercooler (if equipped). Start the engine. Operate the engine in order to purge the air from the cavities of the engine block. Allow the coolant to warm and allow the coolant level to stabilize. Stop the engine.

3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant within 13 mm (.5 inch) below the bottom of the filler pipe.

4. Clean the radiator filler cap. Inspect the gaskets of the radiator filler cap. If the gaskets of the radiator filler cap are damaged, discard the old radiator filler cap and install a new radiator filler cap. If the gaskets of the radiator filler cap are not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the radiator filler cap. The correct pressure is stamped on the face of the radiator filler cap. If the radiator filler cap does not maintain the correct pressure, install a new radiator filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02062273

Cooling System Coolant (ELC) - Change

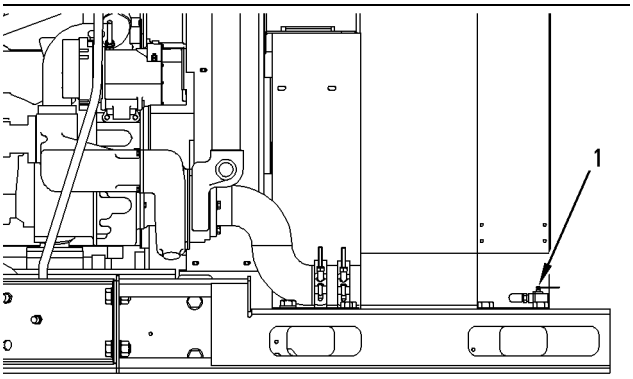
SMCS Code: 1350-044-NL

Use only clean water to flush the cooling system when Extended Life Coolant (ELC) is drained and replaced.

Drain the Cooling System

1. Stop the engine and allow the engine to cool. Close the water inlet for the separate circuit aftercooler (if equipped). Ensure that the engine will not start when the cooling system is drained.

2. Loosen the radiator filler cap slowly in order to relieve any pressure. Remove the radiator filler cap.



g00736141

Illustration 67

(1) Coolant drain

3. Open coolant drain (1).

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Dealer Service Tools:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL
EAME phone: ++41-22-849 40 56
EAME fax: ++41-22-849 49 29

Clean the Cooling System

1. After the cooling system has been drained, flush the cooling system with clean water in order to remove any debris.

2. Close the coolant drain.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Open the water inlet for the separate circuit aftercooler (if equipped). Fill the cooling system with clean water. Install the radiator filler cap. Operate the engine until the temperature reaches 49 °C (120 °F) to 66 °C (150 °F).

4. Stop the engine and allow the engine to cool. Close the water inlet for the separate circuit aftercooler (if equipped). Ensure that the engine will not start when the cooling system is drained. Loosen the radiator filler cap slowly in order to relieve any pressure. Remove the radiator filler cap.

5. Open the coolant drain. Allow the coolant to drain. Flush the cooling system with clean water. Close the coolant drain.

6. Repeat Steps 3, 4, and 5.

Fill the Cooling System

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with Extended Life Coolant (ELC). For the correct capacity of the cooling system, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations”. Do not install the radiator filler cap.

2. Open the water inlet for the separate circuit aftercooler (if equipped). Start the engine. Operate the engine in order to purge the air from the cavities of the engine block. Allow the ELC to warm and allow the coolant level to stabilize. Stop the engine.

3. Check the coolant level. Maintain the coolant to the proper level on the sight gauge (if equipped). If a sight gauge is not equipped, maintain the coolant within 13 mm (.5 inch) below the bottom of the filler pipe.

4. Clean the radiator filler cap. Inspect the gaskets of the radiator cap. If the gaskets of the radiator filler cap are damaged, discard the old radiator filler cap and install a new radiator filler cap. If the gaskets of the radiator filler cap are not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the radiator filler cap. The correct pressure is stamped on the face of the radiator filler cap. If the radiator filler cap does not maintain the correct pressure, install a new radiator filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i02482066

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-544-NL

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender only needs to be added once.

NOTICE
Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Check the cooling system only when the engine is stopped and cool.

⚠ WARNING

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.

2. It may be necessary to drain enough coolant from the cooling system in order to add the Cat ELC Extender.

3. Add Cat ELC Extender according to the requirements for your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” article for more information.

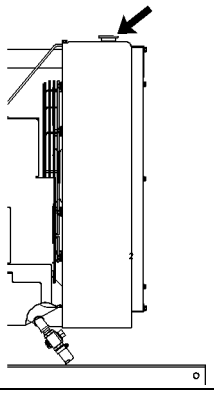
4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1350-535-FLV

Check the coolant level when the engine is stopped and cool.



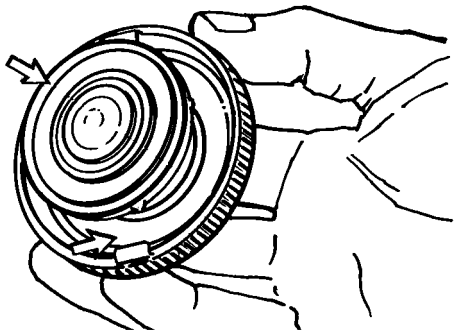
g00285520

Illustration 68
Cooling system filler cap

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.



g00103639

Illustration 69
Typical filler cap gaskets

3. Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

i02837191

Cooling System Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems that are filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval that is stated in the Maintenance Interval Schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC. This includes the following types of coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification -1 (Caterpillar EC-1)
- Cat DEAC (Diesel Engine Antifreeze/Coolant)
- Commercial heavy-duty coolant/antifreeze

Table 26

Recommended Interval		
Type of Coolant	**Level 1**	**Level 2**
Cat DEAC	Every 250 Hours[1]	Yearly[1][2]
Cat ELC	Optional[2]	Yearly[2]

(1) This is the recommended interval for coolant samples for all conventional heavy-duty coolant/antifreeze. This is also the recommended interval for coolant samples of commercial coolants that meet the Cat EC-1 specification for engine coolant.
(2) The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of S·O·S analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- Never collect samples from expansion bottles.
- Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” or consult your Caterpillar dealer.

i01987714

Cooling System Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-008; 1395-554; 7542

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Refer to Operation and Maintenance Manual, “Cooling System Coolant Sample (Level 1) - Obtain” for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engines Fluids Recommendations” or consult your Caterpillar dealer.

i02839449

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and eyes. Do not drink cooling system coolant additive.

NOTICE
Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components.

Excessive supplemental coolant additive concentration could also result in blockage of the heat exchanger, overheating, and/or accelerated wear of the water pump seal.

Do not exceed the recommended amount of supplemental coolant additive concentration.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” and to Special Publication, GECJ0003, “Cat Shop Supplies and Tools” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to applicable regulations and mandates.

Note: Caterpillar recommends an S·O·S coolant analysis (Level 1).

Cooling Systems that Use Conventional Coolant

This maintenance procedure is required for conventional coolants such as DEAC.**This maintenance is NOT required for cooling systems that are filled with Extended Life Coolant.**

Test the Concentration of the SCA

NOTICE
Do not exceed the recommended six percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit.

Add the SCA, If Necessary

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly.
2. If necessary, drain some coolant in order to allow space for the addition of the SCA.
3. Add the proper amount of SCA. For the proper amount of SCA, refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic. The proper concentration of SCA depends on the type of coolant that is used. For the proper concentration of SCA, refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”.
4. Clean the cooling system filler cap. Install the cooling system filler cap.

Cooling Systems that Use Water and SCA

Test the Concentration of the SCA

Test the concentration of the SCA with a 298-5311 Coolant Nitrite Test Kit for SCA or perform an S·O·S Coolant Analysis. The test kit includes the following items: a tool for the testing, 30 ampoules for testing nitrite, instructions, and a case. 294-7420 Test Kit contains the refill ampoules for the 298-5311 Coolant Nitrite Test Kit. Use the instructions that are included with the test kit in order to properly conduct the testing.

Refer to this Operation and Maintenance Manual, “Maintenance Interval Schedule” for the times at which the procedures should be conducted. Test the concentration of the SCA more frequently if more frequent testing is indicated by the results of the S·O·S Coolant Analysis.

NOTICE
Do not exceed the recommended eight percent supplemental coolant additive concentration.

Add the SCA, If Necessary

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly.
2. If necessary, drain some coolant in order to allow space for the addition of the SCA.
3. Add the proper amount of SCA. For the proper amount of SCA, refer to this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic. For the proper concentration of SCA, refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”.
4. Clean the cooling system filler cap. Install the cooling system filler cap.

i03645060

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime. Refer to this Operation and Maintenance Manual, “Maintenance Interval Schedule” for the proper maintenance interval.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE
Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to two articles in the Disassembly and Assembly Manual, “Water Temperature Regulators - Remove and Water Temperature Regulators - Install” for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i02871204

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

The crankshaft vibration damper limits the torsional vibration of the crankshaft. The visconic damper has a weight that is located inside a fluid filled case.

Damage to the crankshaft vibration damper or failure of the damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive torsional vibrations.

A damper that is hot may be the result of excessive torsional vibration, worn bearings, or damage to the damper. Use an infrared thermometer to monitor the temperature of the damper during operation. Follow the instructions that are included with the infrared thermometer. If the temperature reaches 100°C (212 °F), consult your Caterpillar dealer.

Inspect the damper for evidence of dents, cracks, and leaks of the fluid.

If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, and smooth.

If the fluid leak is oil, inspect the crankshaft seals for leaks. If a leak is observed, replace all of the seals.

Inspect the damper and repair or replace the damper for any of the following reasons.

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- The crankshaft bearings are showing excessive wear.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Dampers With Sampling Ports

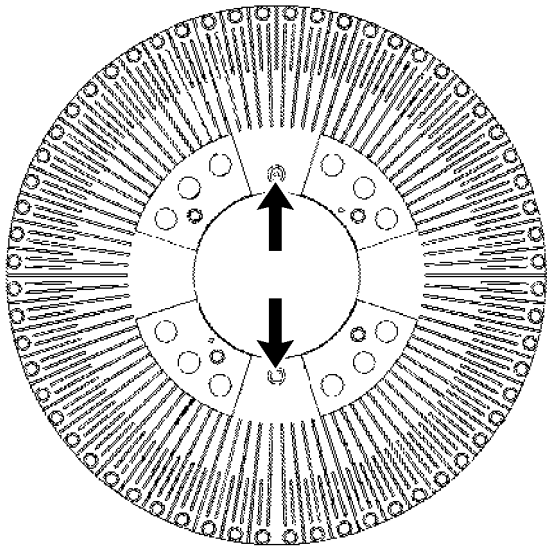


Illustration 70 g00819045

Some dampers have ports for fluid samples. If the damper has no external damage, collect a sample of the damper fluid. The fluid should be analyzed in order to check for a loss of viscosity. Use the results of the analysis to determine if the damper should be rebuilt or replaced. Kits for fluid samples are available from the address that follows. Return the kits to the same address for analysis.

Hasse & Wrede GmbH
Georg-Knorr-Straße 4
12681 Berlin
Germany
Phone: +49 30 9392-3135
Fax: +49 30 9392-7-3135
Alternate phone: +49 30 9392-3156
Alternate fax: +49 30 9392-7-3156

The typical limit for the degradation of the damper fluid viscosity that is used by Hasse & Wrede GmbH is 20 percent for the majority of applications. The reports from Hasse & Wrede should indicate that the fluid samples meet this viscosity limit.

Dampers Without Sampling Ports

Some dampers do not have a port for a fluid sample. These dampers must be rebuilt or the dampers must be replaced when one of the following criteria has been met:

- The damper has been operated for 20000 hours.
- The engine is undergoing a major overhaul.

Removal and Installation

Refer to the Disassembly and Assembly Manual, “Vibration Damper - Remove and Install” article or consult your Caterpillar dealer for information about damper replacement.

i01228274

Electrical Connections - Check

SMCS Code: 4459-535

Check all exposed electrical connections for tightness.

Check the following devices for loose mounting or for physical damage:

- transformers
- fuses
- capacitors
- lightning arrestors

Check all lead wires and electrical connections for proper clearance.

i01646701

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls “DO NOT OPERATE”.

NOTICE
Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used in order to prevent electrical components from being damaged by excessive water when you clean the engine. Avoid electrical components such as the alternator, the starter, and the ECM.

i01553486

Engine Air Cleaner Element (Dual Element) - Clean/Replace

SMCS Code: 1051; 1054-037

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element. The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable or washable. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element. When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.

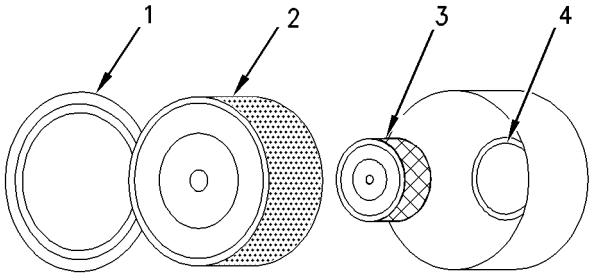


Illustration 71 g00736431

(1) Cover
(2) Primary air cleaner element
(3) Secondary air cleaner element
(4) Turbocharger air inlet

1. Remove the cover. Remove the primary air cleaner element.
2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

Note: Refer to “Cleaning the Primary Air Cleaner Elements”.

3. Cover the turbocharger air inlet with tape in order to keep dirt out.
4. Clean the inside of the air cleaner cover and body with a clean, dry cloth.

5. Remove the tape for the turbocharger air inlet. Install the secondary air cleaner element. Install a primary air cleaner element that is new or cleaned.

6. Install the air cleaner cover.

7. Reset the air cleaner service indicator.

Cleaning the Primary Air Cleaner Elements

NOTICE
Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. When the primary air cleaner element is cleaned, check for rips or tears in the filter material. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean primary air cleaner elements while dirty elements are being cleaned.

NOTICE
Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the primary air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are two common methods that are used to clean primary air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

Pressurized air can be used to clean primary air cleaner elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

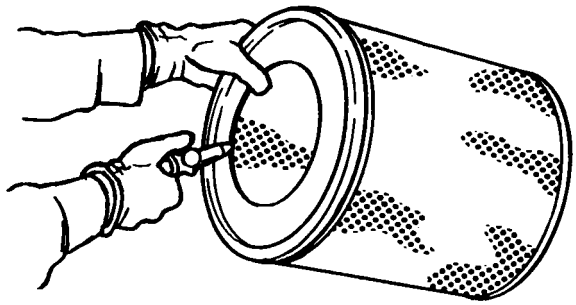


Illustration 72 g00281692

Note: When the primary air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the primary air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning primary air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to “Inspecting the Primary Air Cleaner Elements”.

Inspecting the Primary Air Cleaner Elements

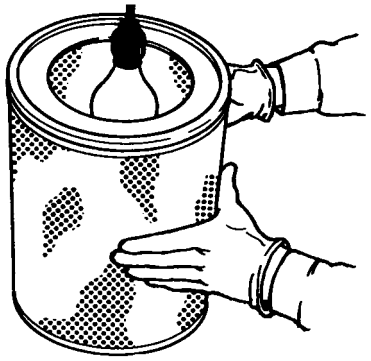


Illustration 73 g00281693

Inspect the clean, dry primary air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the primary air cleaner element. Rotate the primary air cleaner element. Inspect the primary air cleaner element for tears and/or holes. Inspect the primary air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the primary air cleaner element to a new primary air cleaner element that has the same part number.

Do not use a primary air cleaner element that has any tears and/or holes in the filter material. Do not use a primary air cleaner element with damaged pleats, gaskets or seals. Discard damaged primary air cleaner elements.

Storing Primary Air Cleaner Elements

If a primary air cleaner element that passes inspection will not be used, the primary air cleaner element can be stored for future use.

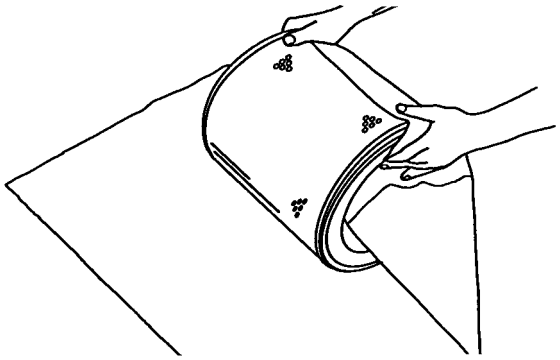


Illustration 74 g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. An airflow restriction may result. To protect against dirt and damage, wrap the primary air cleaner elements in Volatile Corrosion Inhibited (VCI) paper.

Place the primary air cleaner element into a box for storage. For identification, mark the outside of the box and mark the primary air cleaner element. Include the following information:

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i01553508

Engine Air Cleaner Element (Single Element) - Clean/Replace

SMCS Code: 1051; 1054-037

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.

- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

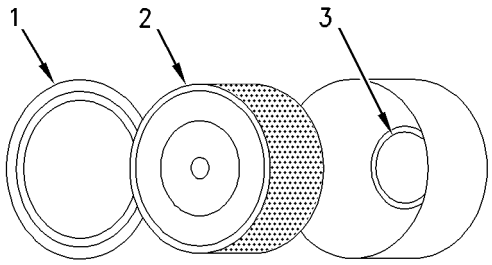


Illustration 75 g00735127

(1) Cover
(2) Air cleaner element
(3) Turbocharger air inlet

1. Remove the air cleaner cover. Remove the air cleaner element.

Note: Refer to “Cleaning the Air Cleaner Elements”.

2. Cover the air inlet with tape in order to keep dirt out.

3. Clean the inside of the air cleaner cover and body with a clean, dry cloth.

4. Remove the tape for the air inlet. Install an air cleaner element that is new or cleaned.

5. Install the air cleaner cover.

6. Reset the air cleaner service indicator.

Cleaning the Air Cleaner Elements

NOTICE
Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

The air cleaner element can be used up to six times if the element is properly cleaned and inspected. When the air cleaner element is cleaned, check for rips or tears in the filter material. The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean air cleaner elements while dirty elements are being cleaned.

NOTICE
Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are two common methods that are used to clean air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

Pressurized air can be used to clean air cleaner elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

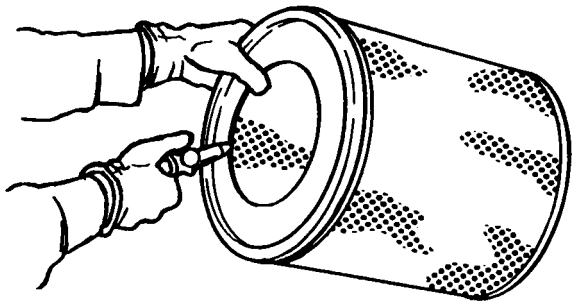


Illustration 76 g00281692

Note: When the air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to “Inspecting the Air Cleaner Elements”.

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to “Inspecting the Air Cleaner Elements”.

Inspecting the Air Cleaner Elements

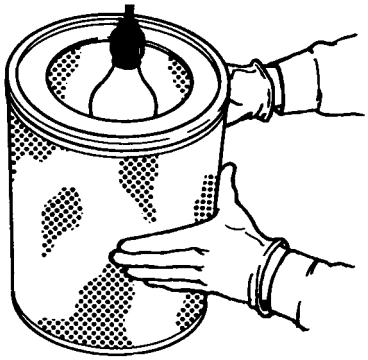


Illustration 77 g00281693

Inspect the clean, dry air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the air cleaner element. Rotate the air cleaner element. Inspect the air cleaner element for tears and/or holes. Inspect the air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the air cleaner element to a new air cleaner element that has the same part number.

Do not use an air cleaner element that has any tears and/or holes in the filter material. Do not use an air cleaner element with damaged pleats, gaskets or seals. Discard damaged air cleaner elements.

Storing Air Cleaner Elements

If an air cleaner element that passes inspection will not be used, the air cleaner element can be stored for future use.

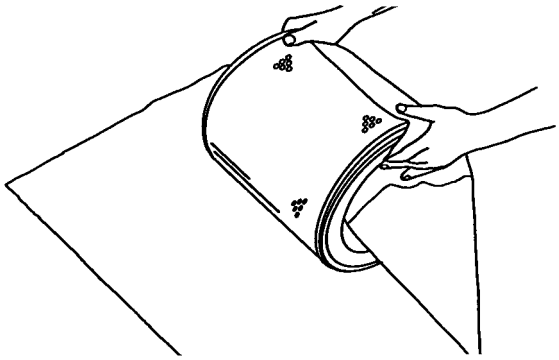


Illustration 78 g00281694

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. An airflow restriction may result. To protect against dirt and damage, wrap the air cleaner elements in Volatile Corrosion Inhibited (VCI) paper.

Place the air cleaner element into a box for storage. For identification, mark the outside of the box and mark the air cleaner element. Include the following information:

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i01397712

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

A service indicator may be mounted on the air cleaner element or in a remote location.

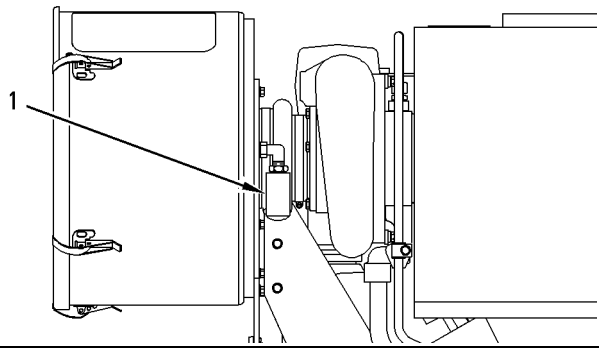


Illustration 79 g00736586

(1) Service indicator

Some engines may be equipped with a different service indicator.

Observe the service indicator. Clean the air cleaner element or replace the air cleaner element when the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.
- The air restriction reaches 6 kPa (25 inches of H_2O).

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated rpm. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the fitting for the service indicator may be plugged.

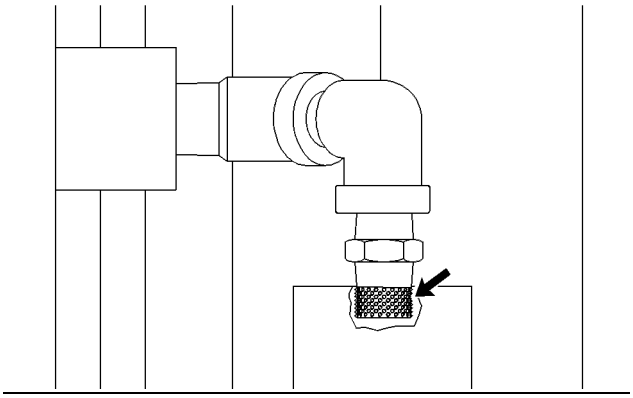


Illustration 80 g00351792

Porous filter

A porous filter is part of a fitting that is used for mounting of the service indicator. Inspect the filter for cleanliness. Clean the filter, if necessary. Use compressed air or a clean, nonflammable solvent.

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i01397717

Engine Air Precleaner - Clean

SMCS Code: 1055-070

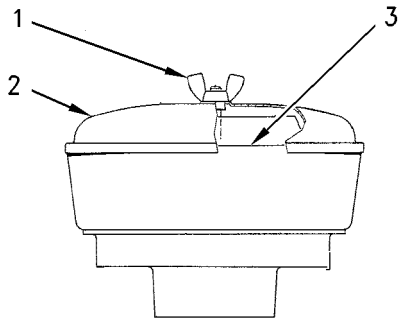


Illustration 81 g00736588

Typical precleaner

(1) Wing nut
(2) Cover
(3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the precleaner, install cover (2) and wing nut (1).

Note: When the engine is operated in dusty applications, more frequent cleaning is required.

i01225429

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

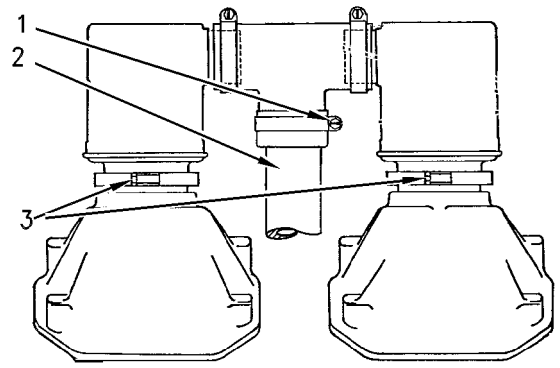


Illustration 82 g00597463

1. Loosen clamp (1). Slide the clamp down on tube (2).
2. Loosen clamps (3). Remove both breathers as a unit.

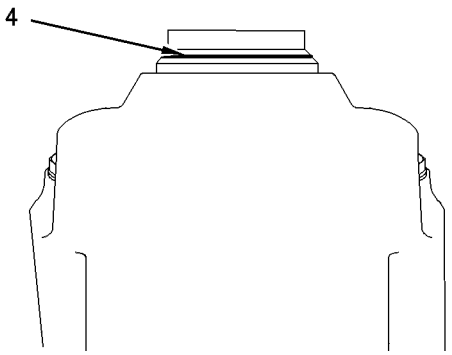


Illustration 83 g00597465

3. Remove O-ring seals (4) from the valve covers. Inspect the O-ring seals for good condition. Obtain new O-ring seals, if necessary.

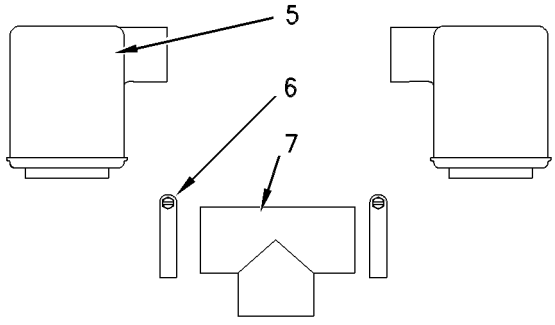


Illustration 84 g00597466

4. Remove two clamps (6). Remove both breathers (5) from hose tee (7).

Inspect the hose tee for cracks. If the tee is cracked, discard the old tee and obtain a new tee for installation.

5. Turn the breathers upside-down in order to inspect the condition of the breather elements.

   Clean the breather elements with clean, nonflammable solvent. If the breather elements remain contaminated after the cleaning, discard the breathers and obtain new breathers. Do not attempt to disassemble the breathers.

   Allow the breather elements to dry before installation.

Note: Coat the rubber parts with clean engine oil or petroleum jelly in order to make installation easier.

6. Place clamps (6) over the parts of hose tee (7) that will receive breathers (5). Install the breathers into the tee. Tighten the clamps to the torque that is listed in the Service Manual, “Specifications”.

7. Coat O-ring seals (4) with clean engine oil. Place the O-ring seals on the valve covers.

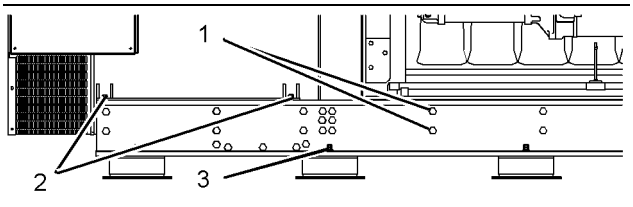
8. Place clamps (3) around the parts of the breathers that will be attached to the valve covers. Install both breathers as a unit. Tighten the clamps.

9. Place clamp (1) on the part of the hose tee that will receive tube (2). Install the tube into the hose tee. Tighten the clamp to the torque that is listed in the Service Manual, “Specifications”.

i03214182

Engine Mounts - Check

SMCS Code: 1152-535



g01340704

Illustration 85

Typical configuration of mounting bolts for a Caterpillar genset

(1) Mounting bolts for the engine
(2) Mounting bolts for the generator
(3) Levelling bolts for the isolators

Misalignment of the engine and the driven equipment will cause extensive damage. Excessive vibration can lead to misalignment. Excessive vibration of the engine and the driven equipment can be caused by the following conditions:

- Improper mounting
- Misalignment of driven equipment
- Loose bolts
- Deterioration of the isolators

Ensure that the mounting bolts are tightened to the proper torque. For standard torques, see Specifications, SENR3130, “Torque Specifications”.

Ensure that the isolators are free of oil and contamination. Inspect the isolators for deterioration. Ensure that the bolts for adjusting the isolator are correctly adjusted and secured with the locking nut. Correctly adjusted isolators provide even support for the engine base. Each isolator should impose nearly identical force on the base rail. Each isolator should bear the same portion of the weight of the genset.

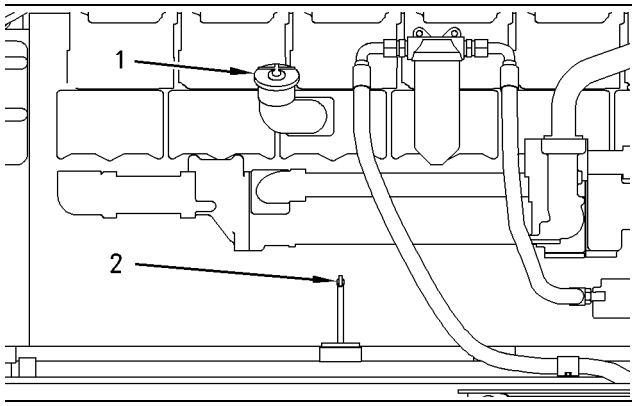
Replace any isolator that shows deterioration. For more information, see the literature that is provided by the OEM of the isolators. Also see the Application and Installation Guide for the engine. Consult your Caterpillar dealer for assistance.

i02064762

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

The most accurate check of the oil level is performed when the engine is stopped. Perform this maintenance on a surface that is as level as possible.



g00736608

Illustration 86

(1) Oil filler cap
(2) Oil level gauge

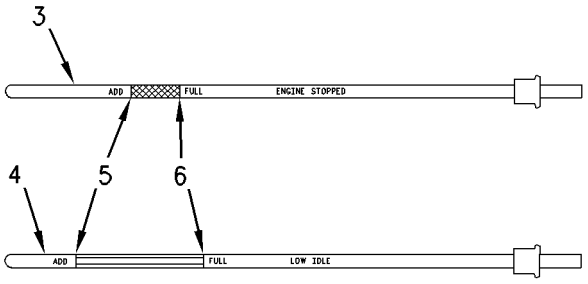


Illustration 87 g00736607

(3) “ENGINE STOPPED” side. (4) “LOW IDLE” side. (5) “ADD” mark. (6) “FULL” mark.

1. Ensure that oil level gauge (2) is seated.

a. If the engine is stopped, remove oil level gauge (2). Observe the oil level on “ENGINE STOPPED” side (3). The oil level should be between “ADD” mark (5) and “FULL” mark (6).

b. If the engine is operating, reduce the engine speed to low idle. Remove oil level gauge (2) and observe the oil level on “LOW IDLE” side (4). The oil level should be between “ADD” mark (5) and “FULL” mark (6).

NOTICE
Operating your engine when the oil level is above the “FULL” mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. If necessary, remove oil filler cap (1) and add oil. For the correct oil to use, see this Operation and Maintenance Manual, “Refill Capacities and Recommendations” topic in the Maintenance Section. Do not fill the crankcase above “FULL” mark (6). Clean the oil filler cap. Install the oil filler cap.

i03542996

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine. S·O·S oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE
Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEgj0047, “How To Take A Good S·O·S Oil Sample”. Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i03006778

Engine Oil and Filter - Change

SMCS Code: 1318-510

⚠ WARNING

Hot oil and components can cause personal injury.

Do not allow hot oil or components to contact skin.

The oil change interval will be affected by the following items:

- Air/fuel ratio
- Ambient air conditions
- Engine application
- Fuel type
- Oil type
- Size of the oil sump

The S·O·S oil analysis program analyzes used oil in order to determine if the oil change interval is suitable for your specific engine. In the absence of S·O·S oil analysis, change the engine oil and engine oil filters according to the interval that is listed in Table 27.

Table 27

3500B Generator Set Engine Oil Change Intervals		
Engine	**Sump Capacity**	**Oil Change Interval**
Engines With a Standard Sump		
3508B	227 L (60 US gal)	Every 500 Service Hours
3512B	318 L (84 US gal)	
3516B	405 L (107 US gal)	
Engines With a Deep Sump		
3508B	443 L (117 US gal)	Every 1000 Service Hours
3512B	625 L (165 US gal)	
3516B	807 L (213 US gal)	

Drain the Oil

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed when the cold oil is drained. Drain the crankcase when the oil is warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will allow the waste particles to be recirculated through the engine lubrication system with the new oil.

1. After the engine has been operated at normal operating temperature, STOP the engine.
2. Drain the oil according to the equipment on the engine.

Note: Drain the oil into a suitable container. Dispose of the oil according to local regulations.

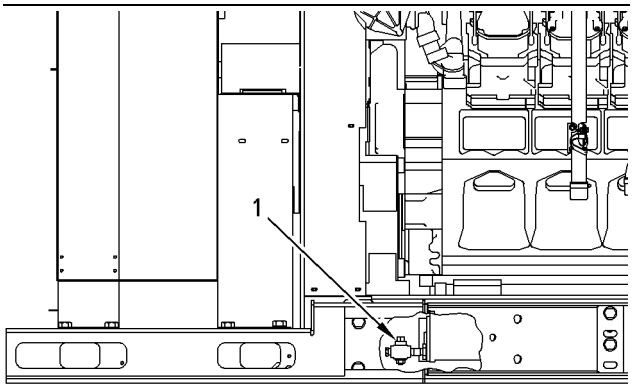


Illustration 88 g00736656

(1) Oil drain

   a. Open oil drain (1). After the oil has drained, close the oil drain.
   b. If a suction device is inserted into the oil pan, ensure that the suction device is clean. This will prevent dirt from entering into the oil pan. Be careful not to strike the engine oil suction tubes or the piston cooling jets.
   c. If a suction device that attaches to the oil drain is used, ensure that the suction device is clean. Attach the suction device to the oil drain. Open the oil drain. After the oil has drained, close the oil drain and remove the suction device.

Replace the Oil Filter Elements

Replace the engine oil filters when either of the following conditions are met:

- Every oil change

- The engine oil filter differential pressure reaches 103 kPa (15 psi).

Service tools are available to aid in the service of oil filters. Consult your Caterpillar dealer for the part names and the part numbers. Follow the instructions that are supplied with the service tools. If the service tools are not used, perform the following appropriate procedure.

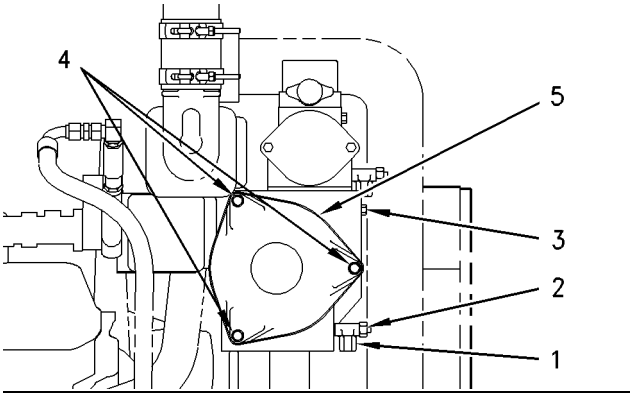


Illustration 89 g00736657

(1) Drain
(2) Drain valve
(3) Plug
(4) Bolts
(5) Cover

Note: Drain the oil into a suitable container. Dispose of the oil according to local regulations.

1. Connect a hose to drain (1). Place the other end of the hose into a suitable container in order to collect the oil.

2. Open drain valve (2). Remove plug (3). Allow the oil to drain. Clean the plug and install the plug. Close the drain valve. Remove the hose from the drain.

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

Note: Some oil will remain in the housing after the oil has been drained. This oil will pour out of the housing when cover (5) is removed. Prepare to catch the oil in a suitable container. Clean up any spilled oil with rags. DO NOT use absorbent particles to clean up the oil.

3. Be alert to the spring force. Gradually loosen but do not remove bolts (4). Before removing bolts (4), pry the cover (5) loose in order to relieve any spring pressure. Remove cover (5). Remove the O-ring seal on the inside of the cover.

4. Clean cover (5) and clean the O-ring seal. Clean the inside of the oil filter housing.

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

5. Install new oil filter elements.

6. Inspect the O-ring seal. Ensure that the surfaces for the O-ring seal are clean. Install a new O-ring seal if the old O-ring seal is damaged or deteriorated.

7. Install cover (5). Ensure that the springs are seated properly between the cover and the oil filter elements.

Inspect the Used Oil Filter Elements

Cut the used oil filter element open with a utility knife. Remove the metal wrap. Cut the filter element free from the end caps. Spread apart the pleats and inspect the element for metal debris. An excessive amount of debris in the element may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the element. Ferrous metals may indicate wear on the steel and the cast iron parts of the engine. Nonferrous metals may indicate wear on the aluminum parts, the brass parts, or the bronze parts of the engine. Parts that may be affected include the following components: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter element. If an excessive amount of debris is found in the oil filter element, consult your Caterpillar dealer in order to arrange for further oil analysis.

Fill the Crankcase

1. Remove the oil filler cap. Fill the crankcase through the oil filler tube only. For the correct type and the amount of oil to use, refer to this Operation and Maintenance Manual (Maintenance Section), “Refill Capacities and Recommendations”. Clean the oil filler cap. Install the oil filler cap.

NOTICE
To prevent crankshaft or bearing damage, crank engine with fuel off to fill all filters before starting.

Do Not crank engine for more than 30 seconds.

2. Close the fuel supply line and crank the engine until the oil pressure gauge indicates 70 kPa (10 psi). Open the fuel supply line. Allow the starting motor to cool for two minutes before cranking again.

3. Follow the Operation and Maintenance Manual (Operation Section), “Starting The Engine” procedure. Operate the engine at low idle for two minutes. This will ensure that the lubrication system has oil and that the oil filters are filled with oil. Inspect the engine for oil leaks. Ensure that the oil level is at the “FULL” mark on the “LOW IDLE” side of the oil level gauge.

4. Stop the engine and allow the oil to drain back into the sump for a minimum of ten minutes.

5. Remove the oil level gauge and check the oil level. Maintain the oil level to the “FULL” mark on the “ENGINE STOPPED” side of the oil level gauge.

i00626013

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE
During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i01537777

Engine Speed/Timing Sensor - Clean/Inspect

SMCS Code: 1905-040; 1905-070; 1907-040; 1907-070

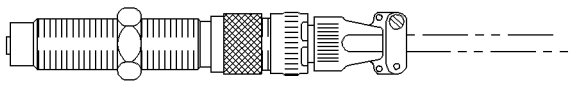


Illustration 90 g00293337
Typical engine speed/timing sensor

1. Remove the engine speed/timing sensor from the flywheel housing. Check the condition of the end of the engine speed/timing sensor. Check for signs of wear and contaminants.

2. Clean the metal shavings and other debris from the face of the magnet.

3. Install the engine speed/timing sensor according to the information in the Service Manual, “Specifications”.

i02939209

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

Note: For procedures on adjusting the valve lash and adjusting the valve bridge, see System Systems Operation/Testing and Adjusting, “Valve Lash and Valve Bridge Adjustment”. Consult your Caterpillar dealer for assistance.

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

⚠ WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Valve Bridge

Check the valve bridge and adjust the valve bridge, if necessary. Perform the procedure for both valve bridges for each cylinder. After the valve bridge is checked for each cylinder, proceed with the valve lash adjustment, if necessary.

Engine Valve Lash

NOTICE
Only qualified service personnel should perform this maintenance. Refer to the Systems Operation/Testing and Adjusting Manual, “Valve Lash and Valve Bridge Adjustment” article or consult your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

The valve bridge adjustment must be performed before making a valve lash adjustment. If the valve lash is within the tolerance, an adjustment of the valve lash is NOT necessary.

For the valve lash setting, see the engine's Specifications manual. For the procedure to set the valve lash, see the engine's Systems Operation/Testing and Adjusting manual.

i01552621

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

1. Inspect the fan drive pulley assembly. If the shaft is loose, an inspection of the internal components should be made.

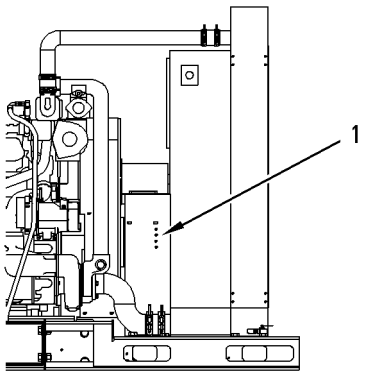


Illustration 91 g00736668

(1) Grease fittings for the fan bearings

Note: If the engine is operated in hot environments, dirty environments, or humid environments, lubricate the fan bearings more frequently.

2. Lubricate the grease fittings for the fan bearings with Bearing Lubricant , or with an equivalent grease.

i01398199

Fuel Control Linkage - Check/Lubricate

SMCS Code: 1257-086; 1257-535

Check the fuel control linkage for proper operation. If necessary, adjust the fuel control linkage. For the adjustment procedure, see the Service Manual Module, “Systems Operation Testing and Adjusting” and see the Service Manual Module, “Specifications”.

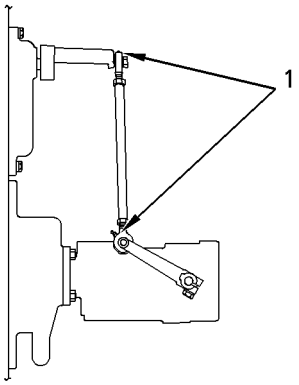


Illustration 92 g00736769

(1) Rod ends

Apply grease to the grease fittings on the rod ends.

Use a hand grease gun and lubricate the grease fittings with MPGM.

i01398238

Fuel System - Prime

SMCS Code: 1250-548; 1258-548

1. Open the fuel supply valve. Ensure that the engine will not start during the priming procedure. Turn the start switch to the OFF position.

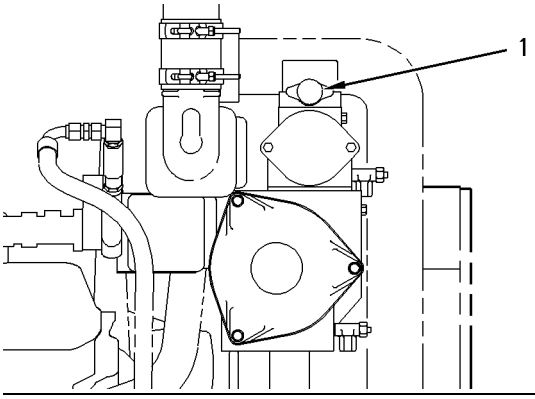


Illustration 93 g00736817

(1) Fuel priming pump plunger

2. Turn the fuel priming pump plunger counterclockwise in order to release the lock plate from the retainer.

3. Operate the fuel priming pump until the air in the fuel system has been pumped through the fuel return line back to the fuel tank.

4. Press the fuel priming pump plunger to the locking position. Turn the fuel priming pump plunger clockwise in order to engage the lock plate in the retainer.

Note: Enable the starting system only after all maintenance has been completed.

Priming Procedure for Dry Starting

If the air cannot be completely purged from the fuel system and the engine will not start, see Special Instruction, SEHS9586, “3500 EUI Fuel Priming Procedure”.

i01398258

Fuel System Primary Filter - Clean/Inspect/Replace

SMCS Code: 1260-510; 1260-571

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

1. Stop the engine. Ensure that the engine will not start during this procedure.

2. Shut off the fuel supply valve to the engine.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

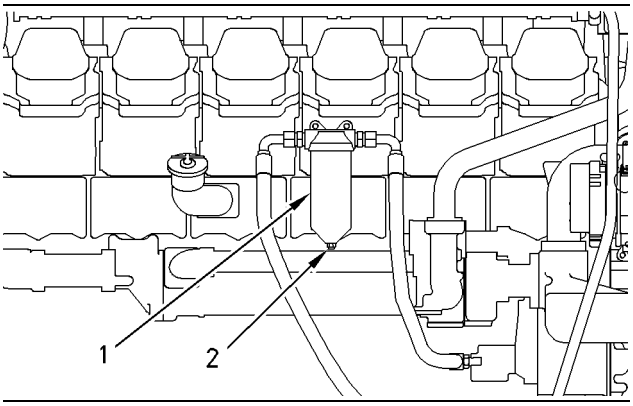


Illustration 94 g00736845

(1) Filter case
(2) Nut

3. Loosen nut (2). Hold filter case (1) and remove nut (2). Prepare to catch the fuel that is inside of the filter case with a suitable container. Remove the filter case from the mounting bolt.

4. Remove the element and wash the element in clean, nonflammable solvent. Allow the element to dry. Inspect the element. Install a new element if the old element is damaged or deteriorated.

5. Clean the inside of the filter case. Allow the filter case to dry.

6. Inspect the O-ring seals. Obtain new seal rings if the old seal rings are damaged or deteriorated. Ensure that the sealing surfaces for the seals are clean. Install the seals.

NOTICE
Do not fill the fuel filters with fuel before installing them. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

7. Place the element in the filter case. Slide the filter case over the mounting bolt.

8. Install the nut.

9. Open the fuel supply valve.

10. Prime the fuel system. See this Operation and Maintenance Manual, “Fuel System - Prime” topic.

i01398265

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Replace the secondary fuel filter element whenever the following conditions occur:

- The fuel filter differential pressure gauge registers 103 kPa (15 psi).
- The fuel filters have been used for 1000 service hours.

1. Stop the engine. Ensure that the engine will not start during this procedure.

2. Shut off the fuel supply valve to the engine.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

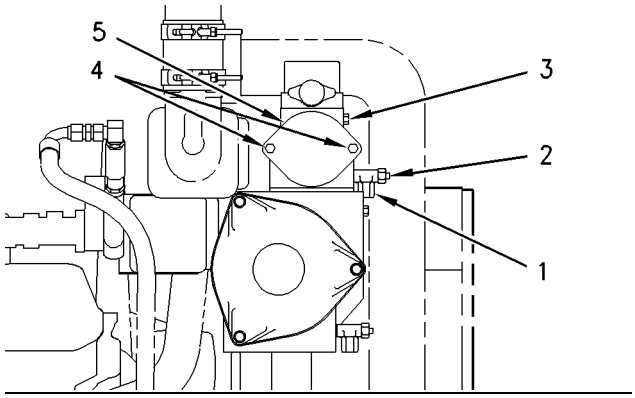


Illustration 95 g00736863

(1) Drain
(2) Drain valve
(3) Plug
(4) Bolts
(5) Cover

3. Connect a hose to drain (1). Place the other end of the hose into a suitable container in order to collect the fuel.

4. Open drain valve (2). Remove plug (3). Allow the fuel to drain. Clean the plug and install the plug. Close the drain valve. Remove the hose from the drain.

Note: Some fuel will remain in the housing after the fuel has been drained. This fuel will pour out of the housing when cover (5) is removed. Prepare to catch the fuel in a suitable container. Clean up any spilled fuel with absorbent towels or pillows. DO NOT use absorbent particles to clean up the fuel.

⚠ WARNING

Personal injury can result from parts and/or covers under spring pressure.

Spring force will be released when covers are removed.

Be prepared to hold spring loaded covers as the bolts are loosened.

5. Be alert to the spring force. Gradually loosen but do not remove bolts (4). Before removing bolts (4), pry cover (5) loose in order to relieve any spring pressure. Remove cover (5). Remove the O-ring seal on the inside of the cover. Remove the fuel filter elements.

6. Clean cover (5) and clean the O-ring seal. Clean the inside of the fuel filter housing.

7. Install new fuel filter elements.

8. Inspect the O-ring seal. Ensure that the surfaces for the O-ring seal are clean. Install a new O-ring seal if the old O-ring seal is damaged or deteriorated.

9. Install cover (5). Ensure that the springs are seated properly between the cover and the fuel filter elements.

10. Open the fuel supply valve. Reconnect the battery.

11. Prime the fuel system. Refer to this Operation and Maintenance Manual, “Fuel System - Prime” topic (Maintenance Section).

i03645042

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tool Catalog” or refer to Special Publication, PECJ0003, “Caterpillar Shop Supplies and Tools Catalog” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Note: Failure to properly close the drain can allow air into the system, which could have detrimental results to performance.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank. A four micron(c) absolute filter for the breather vent on the fuel tank is also recommended. Refer to Special Publication, SENR9620, “Improving Fuel System Durablity”.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i01601944

Generator - Dry

SMCS Code: 4450-569

⚠ WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

Refer to Safety Section, “Generator Isolating for Maintenance” for information regarding the procedure to safely isolate the generator.

If the insulation resistance values are less than the recommended values, one of the following drying procedures must be selected. This decision should be based on the following factors:

- the size of the unit
- the location of the unit
- the equipment that is available
- the experience of personnel

Note: For more information on drying methods, refer to Special Instruction, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

Remove the voltage regulator. Cover all of the inlet openings. Cover all of the discharge holes. Provide an opening at the top of the machine. This opening will allow moisture to evaporate. Preferably, this opening will be located at the fan end. Monitor the winding temperatures. DO NOT APPLY HEAT TOO RAPIDLY. Winding temperature should be raised gradually at a rate of 10 °C (50 °F) per hour up to 85 °C (185 °F). Measure insulation resistance at one hour intervals. Typically, the insulation resistance will slowly drop while the temperature is rising. The insulation resistance will then start to increase at a slow rate until the insulation resistance reaches a constant level.

The following methods can be used for drying a generator:

- Self-circulating air method
- Oven method
- Controlled current method

Self-Circulating Air Method

Run the engine and disconnect the generator load. This will help circulate air. Operate the generator space heaters.

Oven Method

Place the entire generator inside a forced air drying oven for four hours at 65 °C (149 °F).

NOTICE

Use a forced air type oven rather than a radiant type oven.

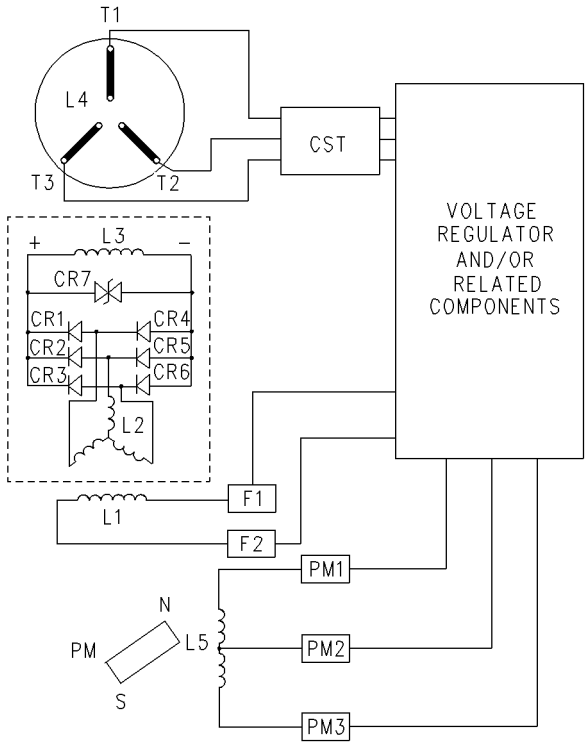
Radiant type ovens can cause localized overheating.

Controlled Current Method

Table 28

Tools Needed		
Part Number	**Description**	**Qty**
8T-0900	Clamp on ammeter (1200 amperes)	1
	External Power Source	1
	Rheostat	1

Heat can be used in order to dry the generator windings. This heat can be created by allowing a controlled current to flow through the generator. No high voltages are generated during the following procedure. Therefore, insulation breakdown will not occur.



g00669571

Illustration 96

Generator Wiring Diagram

(CR1-CR6) Diodes
(CR7) Varistor
(L1) Exciter field (stator)
(L2) Exciter armature (rotor)
(L3) Main field (rotor)
(L4) Main armature (stator)
(L5) Pilot exciter armature
(PM) Permanent magnet
(RFA) Rotating field assembly
(CST) Customer supplied transformer

1. Make an external power source.
2. Refer to the above diagram. Disconnect “F1+” from the voltage regulator. Disconnect “F2-” from the voltage regulator. Disconnect the generator load. Connect the generator output leads “T0”, “T1”, “T2”, and “T3”. Install the clamp-on ammeter to generator output lead “T1”.

Note: When the line current is measured on multiple-lead units, measure the current in each conductor per phase. The currents can then be added.

3. Refer to the above diagram. Connect the rheostat. Adjust the rheostat to the maximum resistance value. Connect the external power source to wires “F1+” and “F2-”.
4. Start the generator set. Run the generator set at idle speed.
5. Monitor the phase current. Gradually increase the engine RPM. Increase the engine RPM until one of the following conditions are met:
   - The rated phase current is obtained.
   - The full generator set speed is obtained.
6. If more phase current is still necessary, slowly turn the rheostat until the rated phase current is reached.
7. On an hourly basis, stop the drying procedure. Check the insulation resistance. Repeat the above steps until the insulation resistance is acceptable.

i01461264

Generator - Inspect

SMCS Code: 4450-040

WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

Refer to Safety Section, “Generator Isolating for Maintenance” for information regarding the procedure to safely isolate the generator.

Proper maintenance of electrical equipment requires periodic visual examination of the generator and periodic visual examination of the windings. Proper maintenance of electrical equipment also requires appropriate electrical checks and appropriate thermal checks. Insulation material should be examined for cracks. The insulation material should be examined for accumulations of dirt and dust. If there is an insulation resistance value that is below normal, a conductive path may be present. This conductive path may be made of one of the following materials:

- Carbon
- Salt
- Metal dust
- Dirt that is saturated with moisture

These contaminants will develop a conductive path which may produce shorts. Cleaning is advisable if heavy accumulations of dirt can be seen or if heavy accumulations of dust can be seen. If excess dirt is the cause of a restriction in the ventilation, cleaning is also advisable. Restricted ventilation will cause excessive heating.

NOTICE
To avoid the possibility of deterioration to the generator windings, do not clean the generator unless there is visual, electrical, or thermal evidence that dirt is present.

If harmful dirt accumulations are present, a variety of cleaning techniques are available. The cleaning procedure that is used may be determined by one of the items on the following list:

- The extent of the cleaning procedure that is being attempted
- The type of enclosure of the generator
- The voltage rating of the generator
- The type of dirt that is being removed

Cleaning (Assembled Generators)

Cleaning may be required at the point of installation. At this point, complete disassembly of the generator may not be necessary or feasible. In this case, a vacuum cleaner should be used to pick up the following items: dry dirt, dust, and carbon. This will prevent the spreading of these contaminants.

A small nonconductive tube may need to be connected to the vacuum cleaner. This will allow the vacuum cleaner to clean the surfaces that are not exposed. After most of the dust has been removed, a small brush may be attached to the vacuum hose in order to loosen dirt that is more firmly attached to the surface.

After the initial cleaning with a vacuum, compressed air may be used to remove the remaining dust and dirt. Compressed air that is used for cleaning should be free of moisture and free of oil. Air pressure should be a maximum of 210 kPa (30 psi) in order to prevent mechanical damage to the insulation. If the above cleaning procedures are not effective, consult a Caterpillar dealer.

Cleaning (Disassembled Generators)

An initial insulation resistance check should be made on the generator in order to confirm electrical integrity. A minimum reading of one megohm would be expected with severely contaminated generators. A zero megohm reading may indicate an insulation breakdown. An insulation breakdown requires more than cleaning. An insulation breakdown requires repair.

A high pressure wash is normally an effective way to clean windings. This includes windings that have been exposed to flooding or windings that have been contaminated by salt. A solution of hot water and detergent is used for this method of cleaning.

A high pressure wash sprays a high velocity fluid stream of this solution over the generator that is being cleaned. This detergent washing is followed by multiple sprays of clean water. The clean water is used in order to remove the detergent or the clean water is used in order to dilute the detergent.

Allow the generator to dry at room temperature. Check the insulation resistance. The insulation resistance should now be normal. If the insulation resistance is not normal, repeat the procedure. It may be necessary to use solvents if the generator is contaminated with oil or if the generator is contaminated with grease.

Note: For more information on drying methods, refer to Special Instructions, SEHS9124, “Cleaning and Drying of Electric Set Generators”.

i03132339

Generator Bearing - Inspect

SMCS Code: 4471-040

The ball bearings that are used in LC5, LC6, and SR5 generators contain grease. This grease is subject to deterioration. If the generator is stored more than one year, without rotating the rotor, new ball bearings may be required. These bearings are greased at the factory. These bearings do not require any additional greasing in the field. Remove any necessary covers in order to inspect the rear bearings of the generators. Front bearings may be inspected through the fan screen. Perform a visual inspection for obvious damage, for corrosion, or for an excessive amount of purged grease around the bearing sleeves. Small amounts of purged grease are expected. Grease that covers the brackets or the windings is excessive.

Bearing inspection should include the collection of vibration data. Refer to this Operation and Maintenance Manual, “Generator Set Vibration - Test/Record” for further information concerning checking the vibration levels.

Bearing temperature should also be measured and recorded as a part of this inspection. Refer to this Operation and Maintenance Manual, “Generator Bearing Temperature - Test/Record” for further information concerning checking the vibration levels.

If inspection indicates that bearings are free of rust or corrosion, and no noise or excessive vibration occur on start-up, replacement is not necessary.

i03547528

Generator Bearing - Lubricate

SMCS Code: 4471-086

Lubricating Process (If Applicable)

Note: If the generator already has a visible grease point, go to Step 4.

1. Remove either the louver assembly or the rear plate from the rear of the generator housing.

2. Remove the top grease pipe plug and remove the lower grease pipe plug.

3. Install a grease fitting in the grease pipe.

4. Grease the bearings with the appropriate grease from Table 29. Do not mix greases.

Table 29

Bearing Part Number	Bearing Type	Frame Size	Temperature Min/Max[1]	Grease Part Number	Interval	Weight	Volume	Shaft Diameter
108-1760 Ball Bearing	321 BC 225.0 mm (8.9 inch) OD 105.0 mm (4.1 inch) ID	680	−29 °C (−20.2 °F) minimum / 80 °C (176 °F) maximum	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	105.0 mm (4.1 inch)
108-1761 Ball Bearing	322 BC 240.0 mm (9.4 inch) OD 110.0 mm (4.3 inch) ID	690 / 800	−29 °C (−20.2 °F) / 80 °C (176 °F)	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	110.0 mm (4.3 inch)
139-0349 Roller Bearing	Roller	2900 / 2800	−40 °C (−40 °F) / 80 °C (176 °F)	Mobilith SHC220	Every 250 service hours	2.8 g (0.1 oz)	NA	127.0 mm (5.0 inch)
139-0350 Roller Bearing	Roller	2900 / 2800	−40 °C (−40 °F) / 80 °C (176 °F)	Mobilith SHC220	Every 250 service hours	2.8 g (0.1 oz)	NA	127.0 mm (5.0 inch)
154-3032 Ball Bearing	326 BC 280.0 mm (11.0 inch) OD 130.0 mm (5.1 inch) ID	820 / 2600 / 2700	−29 °C (−20.2 °F) / 80 °C (176 °F)	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	130.0 mm (5.1 inch)
241-4644 Bearing	320 BC 215.0 mm (8.5 inch) OD 100.0 mm (3.9 inch) ID	LC7	−29 °C (−20.2 °F) / 60 °C (140 °F)[2]	UNIREX N3	Every 4500 service hours or 12 months	60 g (2.1 oz)	NA	100.0 mm (3.9 inch)
243-5220 Bearing	315 BB 160.0 mm (6.3 inch) OD 75.0 mm (3.0 inch) ID	LC6100 / LC5000	−29 °C (−20.2 °F) / 60 °C (140 °F)[2]	UNIREX N3	Non-regreasable bearing[3]	Non-regreasable bearing	Non-regreasable bearing	75.0 mm (3.0 inch)
261-3545 Bearing	307 BB 80.0 mm (3.1 inch) OD 35.0 mm (1.4 inch) ID	LC2000	−29 °C (−20.2 °F) / 50 °C (122 °F)[2]	UNIREX N3	Non-regreasable bearing[3]	Non-regreasable bearing	Non-regreasable bearing	35.0 mm (1.4 inch)

(continued)

(Table 29, contd)

Bearing Part Number	Bearing Type	Frame Size	Temperature Min/Max[1]	Grease Part Number	Interval	Weight	Volume	Shaft Diameter
262-5921 Bearing	307 BC 80.0 mm (3.1 inch) OD 35.0 mm (1.4 inch) ID	LC2000	−29 °C (−20.2 °F) / 60 °C (140 °F)[2]	UNIREX N3	Non-regreasable bearing[3]	Non-regreasable bearing	Non-regreasable bearing	35.0 mm (1.4 inch)
263-0161 Bearing	309 BC 100.0 mm (3.9 inch) OD 45.0 mm (1.8 inch)	LC3000	−29 °C (−20.2 °F) / 60 °C (140 °F)[2]	UNIREX N3	Non-regreasable bearing[3]	Non-regreasable bearing	Non-regreasable bearing	45.0 mm (1.8 inch)
5P-2448 Ball Bearing	315 BC 160.0 mm (6.3 inch) OD 75.0 mm (3.0 inch) ID	580 / 590	−29 °C (−20.2 °F) / 80 °C (176 °F)	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	75.0 mm (3.0 inch)
6Y-3955 Ball Bearing	220 BC 180.0 mm (7.1 inch) OD 100.0 mm (3.9 inch) ID	450	−29 °C (−20.2 °F) / 80 °C (176 °F)	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	100.0 mm (3.9 inch)
6Y-6488 Ball Bearing	318 BC 190.0 mm (7.5 inch) OD 90.0 mm (3.5 inch)	597	−29 °C (−20.2 °F) / 80 °C (176 °F)	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	90.0 mm (3.5 inch)
311-0843 Ball Bearing	326 BC 280.0 mm (11.0 inch) OD 130.0 mm (5.1 inch) ID	1800 FR	−40 °C (−40 °F) / 80 °C (176 °F)	EA6	Non-regreasable bearing[1]	Non-regreasable bearing	Non-regreasable bearing	130.0 mm (5.1 inch)
311-0844 Ball Bearing	322 BC 240.0 mm (9.4 inch) OD 110.0 mm (4.3 inch) ID	1600 FR	−40 °C (−40 °F) / 80 °C (176 °F)	EA6	Non-regreasable bearing[1]	Non-regreasable bearing	Non-regreasable bearing	110.0 mm (4.3 inch)

(continued)

(Table 29, contd)

Bearing Part Number	Bearing Type	Frame Size	Temperature Min/Max[1]	Grease Part Number	Interval	Weight	Volume	Shaft Diameter
253-9789 Bearing	320 BC 215.0 mm (8.5 inch) OD 100.0 mm (3.9 inch) ID	1400 FR	−29 °C (−20.2 °F) / 80 °C (176 °F)	UNIREX N3	Non-regreasable bearing[1]	Non-regreasable bearing	Non-regreasable bearing	100.0 mm (3.9 inch)
193-4070 Ball Bearing	018 BC 140.0 mm (5.5 inch) OD 90.0 mm (3.5 inch) ID	498/499	−29 °C (−20.2 °F) / 80 °C (176 °F)	2S-3230 Bearing Lubricant	Every 2000 service hours or 12 months	51.2 g (1.8 oz)	59 mL (2 oz)	90.0 mm (3.5 inch)

(1) This temperature is for a generator set that is equipped with a resistive temperature detector (RTD).
(2) Do not exceed 60 °C (140 °F) above the ambient temperature.
(3) This bearing can not be greased. Refer to this Operation and Maintenance Manual, “Generator Bearing - Replace” article for information concerning the replacement of these bearings.
(2) Do not exceed 50 °C (122 °F) above the ambient temperature.

5. Wipe off the excess grease. Remove the top grease fitting. Install the plug.

6. Operate the generator for one hour. This will allow the grease to expand. The expanding grease will force the excess grease from the cavity. When the excess grease is forced from the cavity, the internal pressure will be reduced. The generator should continue to operate until the grease stops purging.

7. Stop the engine. Install the plug in the bottom grease pipe. Wipe off the excess grease.

8. Install the louver assembly or install the rear plate.

i03098183

Generator Bearing - Replace (SR5 Generator Bearings)

SMCS Code: 4471-510

Standard Usage

Caterpillar recommends replacement of the generator bearing at the major overhaul unless the generator is installed in any of the following conditions:

- High temperature environment (refer to the temperature chart in this Operation and Maintenance Manual, “Generator Bearing - Lubricate” article.
- Condensing humidity
- Coastal environment
- Chemical environment
- Abrasive environment

If any of these conditions exist, consult your Caterpillar dealer for the appropriate checks:

- alignment
- environmental
- environmental
- exercising the generator
- temperature
- vibration

Standby Usage

The generator bearings are shielded and greased for the life of the bearing. Some purging of the grease occurs normally with the bearings. Carefully adhere to the recommendations for the following conditions: temperature, vibration, contamination, and alignment. Over time, the bearing grease may deteriorate. This deterioration may cause the grease to loose lubricating properties.

Caterpillar recommends the replacement of the bearing after ten years of service in a standby application in normal conditions. If the bearing is installed in the following conditions, Caterpillar recommends replacement of the bearing in 5 years.

- High temperature environment (Refer to the temperature chart in this Operation and Maintenance Manual, “Generator Bearing - Lubricate” article.
- Condensing humidity
- Coastal environment
- Chemical environment
- Abrasive environment

i03642839

Generator Bearing Temperature - Test/Record

SMCS Code: 4471-081-TA

The monitoring of bearing temperature may prevent premature bearing failure. A generator set should never operate above the recommended set points. Keep records in order to monitor the changes in the temperature of the bearing.

Note: Measure the bearing temperature after the generator reaches normal operating temperature.

Resistive Temperature Detectors (RTDs)

Caterpillar Generators may be equipped with resistance temperature detectors for generator bearings. These detectors are 100 ohm resistance temperature detectors. A resistance temperature detector may be monitored by the optional monitor for the EMCP 3.2/3.3 resistance temperature detector. A resistance temperature detector may be monitored by equipment that is provided by the customer. Consult with your Caterpillar dealer about other methods of measuring the bearing temperature.

The EMCP 3.2/3.3 may be configured to “ALARM” or the EMCP 3.2/3.3 may be configured to “SHUTDOWN”. An alarm is activated if the temperature of the bearing reaches 85 °C (185 °F). A shutdown occurs if the temperature of the bearing reaches 95 °C (203 °F).

Infrared Thermometers

Bearing temperatures can also be recorded with the use of an infrared thermometer. Refer to Special Publication, NENG2500, “Caterpillar Dealer Service Tools Catalog” for a variety of infrared thermometers. Follow the instructions that come with your infrared thermometer.

i02517207

Generator Lead - Check

SMCS Code: 4450-535

The generator set may have braided cables between the generator and the breaker instead of wire cables. Check for signs of wear along the braided cables. Pay particular attention to the cables at the housing for the breaker and the generator terminal box.

If the rubber mats or the insulation on the braided cables show signs of wear at points of contact with other surfaces, replace the mats or the cable immediately. If your generator set does not have rubber mats in place, contact your Caterpillar dealer.

i01228480

Generator Load - Check

SMCS Code: 4450-535-LA

During normal operation, monitor the power factor and monitor generator loading.

When a generator is installed or when a generator is reconnected, ensure that the total current in any one phase does not exceed the nameplate rating. Each phase should carry the same load. This allows the generator to work at the rated capacity. If one phase current exceeds the nameplate amperage, an electrical imbalance will occur. An electrical imbalance can result in an electrical overload and an electrical imbalance can result in overheating .

The power factor can be referred to as the efficiency of the load. This can be expressed as the ratio of kVA to actual kW. The power factor can be calculated by dividing kW by kVA. Power factor is expressed as a decimal. Power factor is used to mean the portion of current that is supplied to a system that is doing useful work. The portion of the current that is not doing useful work is absorbed in maintaining the magnetic field in motors. This current (reactive load) can be maintained without engine power.

Electric sets normally have a low idle setting that is higher than industrial engines. Low idle will be approximately 66% of the full speed that is achieved by 60 Hz units. This would be equal to 80% of the full speed that is achieved by 50 Hz units.

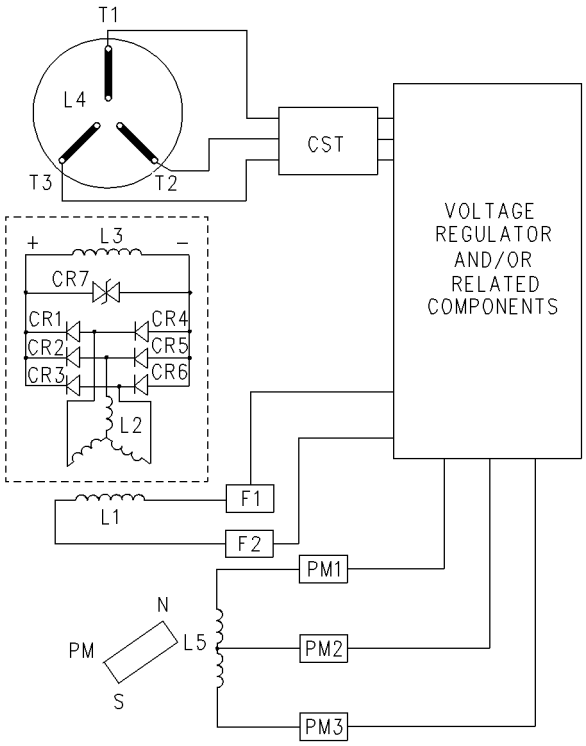
Some electric sets are equipped with Woodward governors and some electric sets are equipped with Caterpillar electronic governors. These electric sets have no low idle stop. On electric sets with mechanical governors and natural gas electric sets, the low idle is set at the factory. Adjustment of the low idle on these machines should only be done by a Caterpillar dealer.

Note: Operating the electric set at low idle speed for an extended time will cause some voltage regulators to shut off. The electric set must be completely shut down and the electric set must be restarted. This will allow the voltage regulator to again produce an output.

i01228520

Generator Set - Test

SMCS Code: 4450-081



g00669571

Illustration 97

Generator Wiring Diagram

(CR1-CR6) Diodes
(CR7) Varistor
(L1) Exciter field (stator)
(L2) Exciter armature (rotor)
(L3) Main field (rotor)
(L4) Main armature (stator)
(L5) Pilot exciter armature
(PM) Permanent magnet
(RFA) Rotating field assembly
(CST) Customer supplied transformer

⚠ DANGER

Dangerous voltages are present at both the generator and the system bus.

Under no circumstances should any attempt be made to connect instrumentation to these points until you are certain all power is off.

All instruments must be connected to the generator and the system bus through potential transformers, which provide a maximum of 600 volts to the instruments.

Failure to follow instructions will result in death or serious injury.

Dangerous voltages are present at the generator's output terminals. Until the power is verified to be OFF, there should not be any device that is connected to the following terminals: (T1), (T2), and (T3). The voltmeter must be connected to the generator through potential transformers. Potential transformers provide a maximum of 600 volts to the voltmeter.

Table 30

Tools Needed		
Part Number	**Part**	**Quantity**
6V-7070	Digital Multimeter	1
	12 VDC battery	1
	Potential Transformer	1

The generator set functional test is a simplified test that can be performed in order to determine if the generator is functional. The generator set functional test should be performed on a generator set that is under load.

The generator set functional test determines if the following statements happen:

- A phase voltage is being generated.
- The phase voltages are balanced.
- The phase voltages change relative to engine speed.

The generator set functional test consists of the following steps:

1. Stop the generator. Connect the potential transformer's high voltage winding to the generator terminals (T1) and (T2). Connect the voltmeter to the low voltage winding. If two transformers are available, connect the high voltage winding of the second transformer to the generator terminals (T1) and (T3). Connect the secondary terminals that correspond to generator terminal (T2) of both transformers together.
2. Disconnect wires “F1+” and “F2-” from the voltage regulator. Disconnect the generator from the load.
3. Connect a 12 VDC automotive battery to wires “F1+” and “F2-”.

NOTICE
Do not operate the generator set at a speed that is higher than one-half of the rated speed.

Higher speeds under these test conditions can cause damage to the system.

4. Operate the generator set at half the rated speed.
5. Measure the AC voltage across the low voltage terminals of the transformer that correspond to the following generator terminals: “T1” and “T2”, “T2” and “T3”, and “T3” and “T1”. Record the voltages.
6. Monitor the voltage between any two of the locations in step 5. Decrease the generator set speed by 10%. Increase the generator set speed by 10%.
7. The voltages that were measured in Step 5 should be nearly equal. These voltages should measure a minimum of 85 VAC.
8. When the generator set speed is decreased by 10%, the voltages that were measured in Step 6 should decrease by 10%. When the generator set speed is increased by 10%, the voltages that were measured in Step 6 should increase by 10% .

i03100396

Generator Set Alignment - Check (Generator Sets)

SMCS Code: 7002-024

The alignment between the engine and the driven equipment must be properly maintained in order to minimize the following problems:

- Bearing problems
- Vibration of the engine crankshaft
- Vibration of the driven equipment

Refer to the following information for more information about the alignment of the generator set:

- Special Instruction, SEHS7654, “Alignment - General Instructions”
- Special Instruction, SEHS7259, “Alignment of Single Bearing Generators”
- Special Instruction, REHS0177, “Alignment of the Close Coupled Two Bearing Generators”

Keep a record of the measurement of the alignment. The record may be used to check the trend of the alignment. The record may be used to analyze the trend of the alignment.

The genset must be aligned when the genset is moved into a final position. The genset must be aligned if the genset is moved into a different position.

i03643886

Generator Set Vibration - Test/Record

SMCS Code: 4450-081-VI

Check for vibration damage.

Vibration may cause the following problems:

- Coupling wear
- Loose fittings
- Fatigue of the metal components of the engine
- Cracks in the cabinet which surrounds the generator
- Cracks in welds
- Excessive noise
- Cracked insulation

The following areas are susceptible to vibration damage:

- Coupling for the generator set
- Generator bearings
- Stator output leads
- Protective sleeving
- Insulation
- Exposed electrical connections
- Transformers
- Fuses
- Capacitors
- Lightning arresters

When a generator set is installed, a vibration plot should be recorded in order to assist in diagnosing potential problems. This vibration plot should be updated yearly. The vibration plot should also be updated when the generator set is moved and when the engine is overhauled. This will allow the trend of the vibration to be monitored and analyzed. A potential problem may be prevented by monitoring the trend of the vibration. If the vibration is approaching the limit of the specification of the component, the problem may be more imminent. Refer to Data Sheet, LEKQ4023, “Linear Vibration” for the allowable limits of vibration.

Caterpillar also recommends recording the vibration of the bearing at the generator bearing bracket.

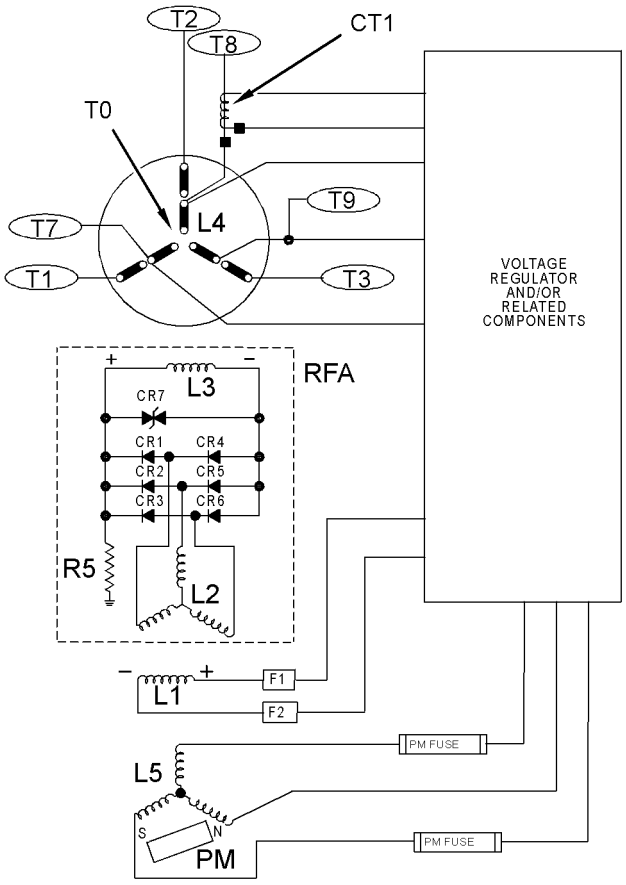
If the vibration exceeds the EDS limits for vibration, check the alignment. Refer to this Operation and Maintenance Manual, “Generator Set Alignment - Check” for the alignment procedure.

Contact the Caterpillar Dealer Service Tools group for information on ordering a vibration analyzer that will meet your needs.

i03736530

Generator Winding - Test

SMCS Code: 4453-081; 4454-081; 4457-081; 4470-081



g01388839

Illustration 98

PMPE Generator wiring diagram for the family of 1800 frames

(CR1-C6) Diodes

(CR7) Varistor

(L1) Exciter stator

(L2) Exciter rotor

(L3) Main rotor

(L4) Main stator

(L5) Permanent magnet generator stator

(PM) Permanent magnet

(RFA) Rotating field assembly

(CT1) Optional voltage droop transformer

(T0, T1, T2, T3, T7, T8, T9) Generator terminals

Table 31

Quantity	Needed Tool
1	Low ohmmeter

Measure the resistance of the following windings: (L1), (L2), (L3), (L4), and (L5). The winding that is being tested must be disconnected from the other components before the resistance can be measured.

Note: The winding temperature affects the resistance. When the winding temperature increases, the winding resistance increases. When the winding temperature decreases, the winding resistance decreases. Therefore, a correct measurement can be performed only when the winding is at room temperature.

The following resistance measurements are approximations. If the measured value is not near the listed approximation, the winding is probably damaged. For a more precise resistance value, consult the Technical Marketing Information (TMI). Refer to the generator arrangement that is in question.

The following windings have very little resistance: (L2), (L4), and (L5). The resistance of these windings will measure near 0 ohms. Use a milliohmmeter to measure the resistance of the windings.

Exciter rotor (L2) – Refer to Table 32.

Main stator (L4) – less than 0.1 ohm

Pilot exciter stator (L5) – less than 0.1 ohm

Use a multimeter in order to measure the resistance of field windings (L1) and (L3).

Exciter field (stator) (L1) – Refer to table 32.

Main field (rotor) (L3) – approximately 0.35 ohms to 1.2 ohms

Note: There should be no continuity between any winding and ground. There should be no continuity between any winding and another winding.

Table 32

	L1 Exciter Field	L2 Exciter Rotor	Main Field for the Rotor
1800 Frame	10.9 ohms	0.05 ohms	.9 ohms
1600 Frame	10 ohms	0.06 ohms	.5 ohms
1400 Frame	11 ohms	0.06 ohms	.35 ohms

i03736629

Generator Winding Insulation - Test

SMCS Code: 4453-081; 4454-081; 4457-081; 4470-081

Recommended Periodic Insulation Tests

⚠ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the "OFF" position. Attach "DO NOT OPERATE" tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

Table 33

Tools Needed		
Part Number	**Part Name**	**Quantity**
300-8648	Insulation Testing Gp	1

Periodically, use an insulation tester to check the insulation resistance of the generator's main stator winding. The frequency of this test is determined by the generator's environment. Previous insulation tester readings will also determine the frequency of this test.

Test the main stator windings with an insulation tester in the following situations:

- The generator set is started for the first time.
- The generator set is removed from storage.
- The generator set is operating in a humid environment. Test every three months.
- The generator set is not protected from the elements in an enclosed area. Test every three months.
- The generator set is installed in an enclosed area. This area needs to be low in humidity and this area needs to have steady temperatures. Test every twelve months (minimum).
- The generator set has not been run under load for three months. Test the generator set weekly. Use space heaters around the generator set if the generator is exposed to a sea water environment or if the humidity is above 75 percent. Also use space heaters if a test result was below 3 megohms.

Space heaters must be used whenever the generator set is not under load. Space heaters must also be used whenever salt is present or whenever high humidity is present. Using a space heater in this fashion is the only way to maintain insulation tester readings above one megohm. Use space heaters only when the generator is not running.

For additional information, refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".

Recommended Procedure for the Insulation Test

⚠ WARNING

Personal injury or death can result from electrocution.

The megohmmeter is applying a high voltage to the circuit.

To avoid electrocution, do not touch the instrument leads without first discharging them. When finished testing also discharge the generator windings.

1. Take the generator out of service.
2. Visually inspect the generator for moisture. If moisture exists, do not perform this insulation test. Dry the unit first. Refer to Special Instruction, SEHS9124, "Cleaning and Drying of Electric Set Generators".
3. Inspect the installation. Determine the equipment that will be tested by the insulation tester.
4. Discharge the capacitance of the windings.
5. Disconnect "T0" from ground.
6. Disconnect the sensing lead wires for the regulator. This may be accomplished by unplugging the harness connectors.
7. Disconnect the PT leads of the load share module.
8. Connect the insulation tester's Black lead to ground.
9. Connect the insulation tester's RED lead to "T0".

10. Set the voltage to the rated voltage of the generator.

11. Use the 30/60 Time Resistance Method:

a. Apply voltage.

b. Observe the readings at 30 seconds. Observe the readings at 60 seconds.

c. Record the 60 second reading. This reading must be corrected for temperature.

d. Record temperature.

e. Record humidity.

f. Remove voltage.

12. Evaluate the readings. The actual value of the resistance may vary greatly between generators. For this reason, the insulation's condition must be evaluated. Base this evaluation on the comparison between the 60 second resistance readings and the readings that were taken on previous dates. These two readings must be taken under similar conditions. If a 60 second resistance reading has a 50 percent reduction from the previous reading, the insulation may have absorbed too much moisture.

Switch the insulation tester to the “OFF” position. This will discharge the insulation tester's leads. Disconnect the insulation tester's leads.

Note: The results from the insulation resistance checks indicate when cleaning and/or repairing is becoming critical. Generally, insulation resistance will vary greatly with temperature. Therefore, always test at the same temperature and humidity. Refer to Illustration 99.

Engine Serial Number_____

Serial Number for the Generator_____

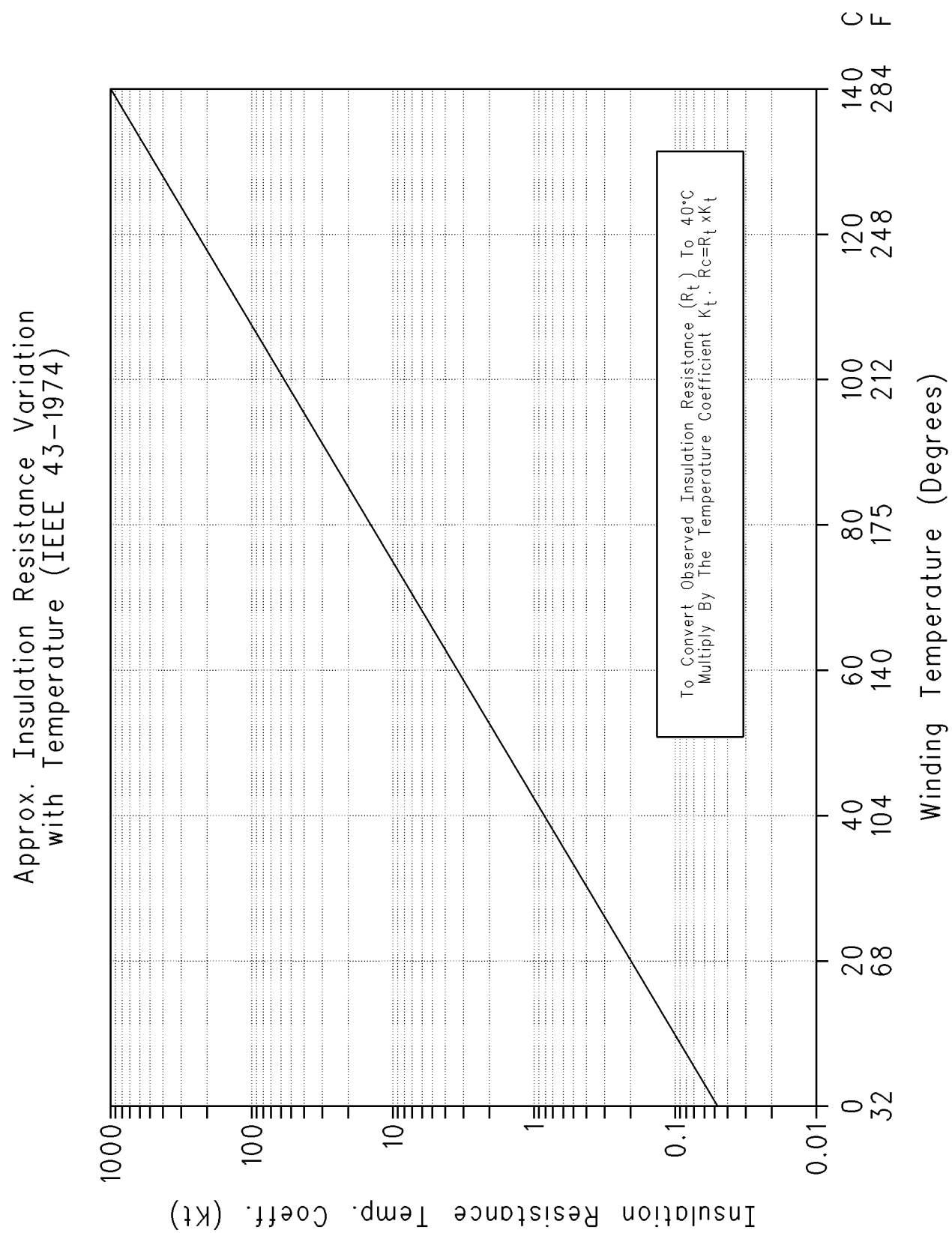


Illustration 99

g00633226

i02121526

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE
Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: Refer to the Specifications, SENR3130, “Torque Specifications” in order to locate the proper torques.

8. Refill the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i01979810

Maintenance Recommendations

SMCS Code: 1000

Service Hours and Fuel Consumption

Experience has shown that maintenance intervals are most accurately based on fuel consumption. Fuel consumption corresponds more accurately to the engine load. Tables 34, 35, and 36 list average ranges of fuel consumption and service hours for a load factor of approximately 60 percent. Use the range of fuel consumption only as a guideline.

Table 34

Maintenance Interval Schedule Service Hours and Fuel Consumption for 3508 and 3508B Engines (1)			
Interval	**Rated Up To 1300 RPM**	**Rated 1301 To 1600 RPM**	**Rated 1601 To 1800 RPM**
250 Service Hours	22700 L (6000 US gal)	27700 L (7200 US gal)	32000 L (8500 US gal)
500 Service Hours	45400 L (12000 US gal)	54400 L (14400 US gal)	64000 L (17000 US gal)
1000 Service Hours	89000 L (23500 US gal)	109000 L (28800 US gal)	128000 L (34000 US gal)
2000 Service Hours	178000 L (47000 US gal)	218000 L (57600 US gal)	257000 L (68000 US gal)
3000 Service Hours	267500 L (70500 US gal)	327500 L (84000 US gal)	386500 L (102000 US gal)
6000 Service Hours	535000 L (141000 US gal)	654000 L (173000 US gal)	774000 L (204000 US gal)
Top End Overhaul	11000 Service Hours	9000 Service Hours	7500 Service Hours
	976000 L (257,500 US gal)		
Second Top End Overhaul	22000 Service Hours	18000 Service Hours	15000 Service Hours
	1952000 L (515000 US gal)		
Major Overhaul	33000 Service Hours	27000 Service Hours	22500 Service Hours
	2928000 L (772500 US gal)		

(1) Fuel consumption is based on a load factor of approximately 60 percent.

Table 35

Maintenance Interval Schedule Service Hours and Fuel Consumption for 3512 and 3512B Engines (1)			
Interval	**Rated Up To 1300 RPM**	**Rated 1301 To 1600 RPM**	**Rated 1601 To 1800 RPM**
250 Service Hours	33400 L (8800 US gal)	41000 L (10800 US gal)	48500 L (12800 US gal)
500 Service Hours	66800 L (17600 US gal)	82000 L (21600 US gal)	97000 L (25600 US gal)
1000 Service Hours	133500 L (35000 US gal)	164000 L (43200 US gal)	194000 L (51200 US gal)
2000 Service Hours	267000 L (70000 US gal)	328000 L (86400 US gal)	388000 L (102400 US gal)
3000 Service Hours	398000 L (105000 US gal)	491000 L (129600 US gal)	582000 L (153600 US gal)
6000 Service Hours	796000 L (210000 US gal)	982000 L (259200 US gal)	1164000 L (307200 US gal)
Top End Overhaul	11000 Service Hours	9000 Service Hours	7500 Service Hours
	1460000 L (385000 US gal)		
Second Top End Overhaul	22000 Service Hours	18000 Service Hours	15000 Service Hours
	2920000 L (770000 US gal)		
Major Overhaul	33000 Service Hours	27000 Service Hours	22500 Service Hours
	4380000 L (1155000 US gal)		

(1) Fuel consumption is based on a load factor of approximately 60 percent.

Table 36

Maintenance Interval Schedule Service Hours and Fuel Consumption for 3516 and 3516B Engines (1)			
Interval	**Rated Up To 1300 RPM**	**Rated 1301 To 1600 RPM**	**Rated 1601 To 1800 RPM**
250 Service Hours	44000 L (11600 US gal)	53000 L (14000 US gal)	64500 L (17000 US gal)
500 Service Hours	88000 L (23200 US gal)	106000 L (28000 US gal)	129000 L (34000 US gal)
1000 Service Hours	176000 L (46500 US gal)	212000 L (56000 US gal)	258000 L (68000 US gal)
2000 Service Hours	352000 L (93000 US gal)	424000 L (112000 US gal)	516000 L (136000 US gal)
3000 Service Hours	528700 L (139500 US gal)	636700 L (168100 US gal)	773000 L (204000 US gal)
6000 Service Hours	1056000 L (279000 US gal)	1272000 L (336000 US gal)	1548000 L (408000 US gal)
Top End Overhaul	11000 Service Hours	9000 Service Hours	7500 Service Hours
	1942000 L (512500 US gal)		
Second Top End Overhaul	22000 Service Hours	18000 Service Hours	15000 Service Hours
	3884000 L (1025000 US gal)		
Major Overhaul	33000 Service Hours	27000 Service Hours	22500 Service Hours
	5826000 L (1537500 US gal)		

(1) Fuel consumption is based on a load factor of approximately 60 percent.

Severe Operation

Severe operation is the use of an engine that exceeds current published standards for that engine. Caterpillar maintains standards for the following engine parameters:

- Horsepower
- Range of rpm
- Fuel consumption
- Fuel quality
- Altitude
- Maintenance intervals
- Selection of oil
- Selection of coolant

- Environmental qualities
- Installation

Refer to the standards for your engine or consult your Caterpillar dealer in order to determine if your engine is operating within the defined parameters.

Severe operation can accelerate component wear. Engines that are operating under severe conditions may need more frequent maintenance intervals for the following reasons:

- Maximum reliability
- Retention of full service life

Because of individual applications, it is not possible to identify all of the factors which can contribute to severe operation. Consult your Caterpillar dealer about the maintenance that is needed for your specific engine.

The following factors can contribute to severe operation: environment, improper operating procedures, and improper maintenance practices.

Environmental Factors

Extreme Ambient Temperatures

Extended operation in environments that are extremely cold or hot can damage components. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces the performance capabilities of the engine.

Note: See this Operation and Maintenance Manual, “Cold Weather Operation” topic (Operation Section), or see Supplement, SEBU5898, “Cold Weather Recommendations”.

Cleanliness

Unless the equipment is cleaned regularly, extended operation in a dirty environment and in a dusty environment can damage components. Built up mud, dirt, and dust can encase components. This can make maintenance difficult. The buildup can contain corrosive chemicals. Corrosive chemicals and salt can damage some components.

Improper Operating Procedures

- Extended operation at low idle
- Minimum cool down periods after high load factor operation
- Operating the engine beyond the guidelines for the engine rating
- Operating the engine at loads that are greater than the rated load
- Operating the engine at speeds that are greater than the rated speed
- Use of the engine for an application that is not approved

Improper Maintenance Practices

- Extension of maintenance intervals
- Not using recommended fuel, lubricants, and coolant/antifreeze

i01981611

Overhaul (Major)

SMCS Code: 7595-020-MJ

The maintenance intervals that are listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule” are expressed in service hours. A more accurate figure to use is fuel consumption. Fuel consumption corresponds more accurately to the engine load. See this Operation and Maintenance Manual, “Maintenance Recommendations” topic for figures that correspond to fuel consumption.

The need for a major overhaul is determined by several factors:

- An increase in oil consumption
- An increase in crankcase blowby
- The total amount of fuel consumption
- The service hours of the engine
- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

An increase of wear metals in the lube oil indicates that the bearings and the surfaces that wear may need to be serviced. An increase in the levels of noise and vibration indicates that rotating parts require service.

Note: It is possible for oil analysis to indicate a decrease of wear metals in the lube oil. The cylinder liners may be worn so that polishing of the bore occurs. Also, the increased use of lube oil will dilute the wear metals.

Monitor the engine as the engine accumulates service hours. Consult your Caterpillar dealer about scheduling a major overhaul.

Note: The driven equipment may also require service when the engine is overhauled. Refer to the literature that is provided by the OEM of the driven equipment.

A major overhaul includes all of the work that is done for the top end overhaul. A major overhaul includes additional parts and labor. Additional parts and labor are required in order to completely rebuild the engine.

For the major overhaul, all of the bearings, seals, gaskets, and components that wear are disassembled. The parts are cleaned and inspected. If necessary, the parts are replaced. The crankshaft is measured for wear. The crankshaft may require regrinding. Alternatively, the crankshaft may be replaced with a Caterpillar replacement part.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component can be reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer for credit on replacement parts. Consult your Caterpillar dealer about repair options for your engine.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the recommendations in Table 37. Your Caterpillar dealer can provide these services and components.

Table 37

Major Overhaul Instructions (1)	
Clean	Oil suction screen
Clean Inspect Test	Aftercooler core (2)
Inspect	Camshafts
	Cylinder block
	Crankshaft vibration damper
	Driven equipment (alignment)
	Flywheel
	Front gear train (gears)
	Fuel system linkage
	Rear gear train (gears)
Inspect Rebuild	Rocker arms
Inspect Rebuild Replace	Connecting rods
	Cylinder head assemblies
	Fuel priming pump
	Fuel transfer pump
	Oil cooler core
	Piston pins
Inspect Replace	Camshaft lifters
	Camshaft thrust washers
	Crankshaft
	Cylinder liners
	Engine mounts
	Engine wiring harness
	Fuel pressure regulating valve
	Pistons (Crowns and Skirts)
	Pushrods
	Spacer plates

(continued)

(Table 37, contd)

Major Overhaul Instructions [1]	
Replace	Camshaft bearings
	Connecting rod bearings
	Crankshaft seals
	Crankshaft thrust plates
	Fuel injectors
	Gear train bushings
	Main bearings
	Piston rings
	Seals and bellows for the exhaust manifold
	Seals and gaskets for the air Inlet manifold

(1) For instructions on removal and installation of components, see the Service Manual, “Disassembly and Assembly” module.
(2) For instructions on cleaning the core, see this Operation and Maintenance Manual, “Aftercooler Core - Clean/Test” topic.

i03139221

Overhaul (Top End)

SMCS Code: 7595-020-TE

The maintenance intervals that are listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule” are expressed in service hours. A more accurate figure to use is fuel consumption. Fuel consumption corresponds more accurately to the engine load. See this Operation and Maintenance Manual, “Maintenance Recommendations” topic for figures that correspond to fuel consumption.

A top end overhaul involves the removal, the inspection, and the rework of the cylinder head components. A few additional components are replaced and serviced.

The top end overhaul (second interval) involves the same service that is performed for the first interval. Because of the number of service hours, some additional components are inspected and/or serviced.

Your Caterpillar dealer can provide these services and components. Your Caterpillar dealer can ensure that the components are operating within the appropriate specifications.

Note: The driven equipment may also require service when the engine is overhauled. Refer to the literature that is provided by the OEM of the driven equipment.

The following definitions explain the terminology for the services that are performed during an overhaul:

Inspect – Inspect the components according to the instructions that are in Caterpillar reusability publications. Refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”. The guidelines were developed in order to help Caterpillar dealers and customers to avoid unnecessary expenditures. New parts are not required if the existing parts can still be used, reconditioned, or repaired. If the components are not in the reusability guidelines, refer to the Service Manual, “Specifications” module.

Rebuild – The component is reconditioned in order to comply with reusability guidelines.

Replace – The service life of the part is exhausted. The part may fail before the next maintenance interval. The part must be replaced with a part that meets functional specifications. The replacement part may be a new part, a CAT remanufactured part, a rebuilt part, or a used part. Some worn components may be exchanged with your Caterpillar dealer for credit on replacement parts. Consult your Caterpillar dealer about repair options for your engine.

If you elect to perform an overhaul without the services of a Caterpillar dealer, be aware of the recommendations in Table 38.

Table 38

Recommendations for Top End Overhauls (1)		
Service	**Top End Overhaul (First Interval)**	**Top End Overhaul (Second Interval)**
Clean	Oil suction screen	
Clean Inspect Pressure test	Aftercooler core (2)	
Inspect	Fuel system linkage	
	-	Connecting rod bearings (3)
	-	Cylinder liners (3)
	-	Piston crowns and skirts (3)
	-	Piston pins (3)
Inspect Rebuild	Rocker arms	
Inspect Rebuild Replace	Cylinder head assemblies	
	Fuel priming pump	
	-	Engine oil pump
	-	Fuel transfer pump
	-	Prelube pump
	-	Scavenge oil pump
Inspect Replace	-	Camshaft lifters
	Engine wiring harness	
	Fuel pressure regulating valve	
	Pushrods	
	Spacer plates	
Rebuild Replace	-	Turbochargers
Replace	Fuel injectors	
	Gaskets and seals for the air inlet manifold	
	Seals and bellows for the exhaust manifold	

(1) For instructions on removal and installation of components, see the Service Manual, “Disassembly and Assembly” module.
(2) For instructions on cleaning the core, see this Operation and Maintenance Manual, “Aftercooler Core - Clean/Test” topic.
(3) For 3508 and 3512 Engines, inspect ONLY ONE of the components from each cylinder bank. For 3516 Engines, inspect ONLY TWO of the components from each cylinder bank. This inspection will provide adequate examples of the condition of the other corresponding components. If the results are questionable, inspect more of the components.

i03101741

Overhaul Considerations

SMCS Code: 7595-043

Severe Operation

Severe operation is the use of an engine that exceeds current published standards for that engine. Caterpillar maintains standards for the following engine parameters:

- Horsepower
- Range of rpm
- Fuel consumption
- Fuel quality
- Altitude
- Maintenance intervals
- Selection of oil
- Selection of coolant
- Environmental qualities
- Installation

Refer to the standards for your engine or consult your Caterpillar dealer in order to determine if your engine is operating within the defined parameters.

Severe operation can accelerate component wear. Engines that are operating under severe conditions may need more frequent maintenance intervals for the following reasons:

- Maximum reliability
- Retention of full service life

Because of individual applications, it is not possible to identify all of the factors which can contribute to severe operation. Consult your Caterpillar dealer about the maintenance that is needed for your specific engine.

The following factors can contribute to severe operation: environment, improper operating procedures, and improper maintenance practices.

Environmental Factors

Extreme Ambient Temperatures

Extended operation in environments that are extremely cold or hot can damage components. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces the performance capabilities of the engine.

Note: See this Operation and Maintenance Manual, “Cold Weather Operation” topic (Operation Section), or see Supplement, SEBU5898, “Cold Weather Recommendations”.

Cleanliness

Unless the equipment is cleaned regularly, extended operation in a dirty environment and in a dusty environment can damage components. Built up mud, dirt, and dust can encase components. This can make maintenance difficult. The buildup can contain corrosive chemicals. Corrosive chemicals and salt can damage some components.

Improper Operating Procedures

- Extended operation at low idle
- Minimum cool down periods after high load factor operation
- Operating the engine beyond the guidelines for the engine rating
- Operating the engine at loads that are greater than the rated load
- Operating the engine at speeds that are greater than the rated speed
- Use of the engine for an application that is not approved

Improper Maintenance Practices

- Extension of maintenance intervals
- Not using recommended fuel, lubricants, and coolant/antifreeze

Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul interval is a maintenance interval that is planned. The engine is rebuilt with certain rebuilt parts or new parts that replace the worn parts.

An overhaul also includes the following maintenance:

- Inspection of all the parts that are visible during the disassembly
- Replacement of the seals and gaskets that are removed
- Cleaning of the internal passages of the engine and the engine block
- Inspecting the alignment of the driven equipment

Most owners will save money by overhauling the engine at the intervals that are recommended in this Operation and Maintenance Manual. Consider the graph in Illustration 100.

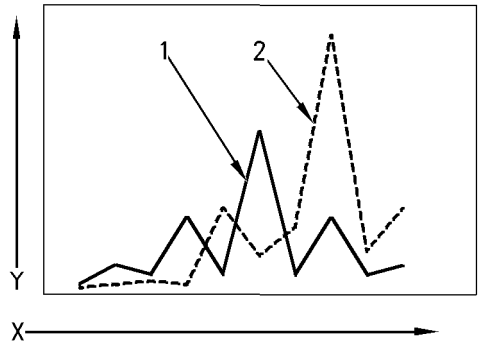


Illustration 100 g00745964

(Y) Cost
(X) Time
(1) Cost of maintenance and repair that is planned
(2) Cost of maintenance and repair that is not planned

In Illustration 100, line (1) represents the maintenance and repair costs for an owner that followed the recommendations for inspection, maintenance, and repair. The peaks represent overhauls.

Line (2) represents the maintenance and repair costs for an owner that chose to operate beyond the recommended intervals. The initial cost of the “repair-after-failure” philosophy is lower. Also, the first overhaul was delayed. However, the peaks are significantly higher than the peaks for the customer that used the “repair-before-failure” philosophy.

The higher peaks result from two key factors:

- Delaying an overhaul until a breakdown increases the chance of a catastrophic failure. This type of failure requires more parts, labor, and cleanup.
- Excessive wear means that fewer components will be reusable. More labor may be required for salvage or repair of the components.

When all of the costs are considered, “repair-before-failure” is the least expensive alternative for most components and engines.

It is not practical to wait until the engine exhibits symptoms of excessive wear or failure. It is not less costly to wait. A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the guidelines for reusable parts.
- The service life of the engine can be extended without the risk of a major catastrophe due to engine failure.
- Achieve the best cost/value relationship per hour of extended service life.

Overhaul Inspection

Refer to the Service Manual for the disassembly and assembly procedures that are necessary in order to perform the required maintenance on the items that are listed. Consult your Caterpillar dealer for assistance.

To determine the reusability publications that are needed to inspect the engine, refer to Guidelines for Reusable Parts and Salvage Operations, SEBF8029, “Index of Publications on Reusability or Salvage of Used Parts”.

The Guidelines For Reusable Parts and Salvage Operations is part of an established Caterpillar parts reusability program. These guidelines were developed in order to assist Caterpillar dealers and customers reduce costs by avoiding unnecessary expenditures for new parts. If the engine parts comply with the established inspection specifications, the parts can be reused.

The use of out-of-spec parts could result in unscheduled downtime and/or costly repairs. The use of out-of-spec parts can also contribute to increased fuel consumption and reduction of engine efficiency. New parts are not necessary if the old parts can be reused, repaired, or salvaged. Otherwise, the old parts can be replaced or exchanged.

Your Caterpillar dealer can provide the parts that are needed to rebuild the engine at the least possible cost.

Overhaul Programs

An economical way to obtain most of the parts that are needed for overhauls is to use Caterpillar remanufactured parts. Caterpillar remanufactured parts are available at a fraction of the cost of new parts. These parts have been rebuilt by Caterpillar and certified for use. The following components are examples of the remanufactured parts:

- Cylinder heads
- Oil Pumps
- Turbochargers
- Water pumps

Consult your Caterpillar dealer for details and for a list of the remanufactured parts that are available.

Your Caterpillar dealer may be offering a variety of overhaul options.

A Flat Rate Overhaul guarantees the maximum price that you will pay for an overhaul. Flat rate prices on preventive maintenance programs or major repair options are available from many servicing dealers for all Caterpillar engines. Consult your Caterpillar dealer in order to schedule a before failure overhaul.

Overhaul Recommendation

Caterpillar recommends a scheduled overhaul in order to minimize downtime. A scheduled overhaul will provide the lowest cost and the greatest value. Schedule an overhaul with your Caterpillar dealer.

Overhaul programs vary between dealers. To obtain specific information about the types of overhaul programs and services, consult your Caterpillar dealer.

i02559063

Radiator - Clean

SMCS Code: 1353-070

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the air nozzle is deadheaded.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”. Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, refer to Special Publication, SEBD0518, “Know Your Cooling System”.

i02246950

Rotating Rectifier - Check

SMCS Code: 4465-535

Check the exciter armature. Ensure that the rotating rectifier is tight. If a failure of a rectifier is suspected, proceed to the “Testing a Three-Diode Rectifier Block” section.

Testing a Three-Diode Rectifier Block

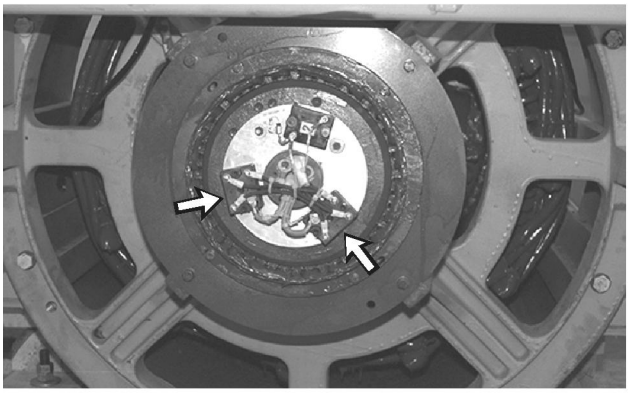


Illustration 101 g00610240

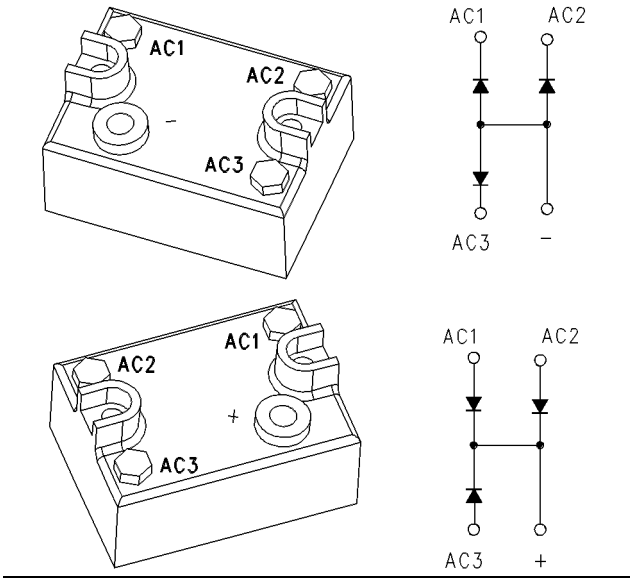


Illustration 102 g00613971

Three-Diode Rectifier Block (two pieces)

The following procedure tests all three diodes within a block. Check the positive rectifier block and the negative rectifier block. If any meter reading does not fall within the given ranges, replace the rectifier block.

1. Set the digital multimeter on the diode range. Remove all leads from the rectifier block.

2. To test the negative rectifier block, follow these steps:

a. Place the red test lead on the negative “-” terminal. Place the black test lead on the following rectifier terminals: “AC1”(3), “AC2”(4), and “AC3”(5). All readings on the meter should be between 0.4 and 1.0.

b. Place the black test lead on the negative “-” terminal. Place the red test lead on the following rectifier terminals: “AC1”(3), “AC2”(4), and “AC3”(5). In all cases, the meter should read “OL” (overload).

3. To test the positive rectifier block, follow these steps:

a. Place the red test lead on the positive “+” rectifier terminal. Place the black test lead on the following rectifier terminals: “AC1”(3), “AC2”(4), and “AC3”(5). In all cases, the meter should read “OL” (overload).

b. Place the black test lead on the positive “+” rectifier terminal. Place the red test lead on the following rectifier terminals: “AC1”(3), “AC2”(4), and “AC3”(5). All readings on the meter should be between 0.4 and 1.0.

Note: A shorted diode can cause damage to the exciter rotor. If a diode is shorted, check the exciter rotor. Refer to the Testing and Adjusting, “Winding - Test” and Testing and Adjusting, “Insulation - Test”. Perform these tests.

Note: This rectifier block also contains varistor “CR7”. “CR7” can be checked by measuring the resistance between the positive “+” rectifier terminal and the negative “-” rectifier terminal. The resistance should be a minimum of 15000.

i03724660

Space Heater - Test

SMCS Code: 4450-081-HTR

The space heater is attached to the rear bearing bracket. The space heater is located in the generator's exciter end.

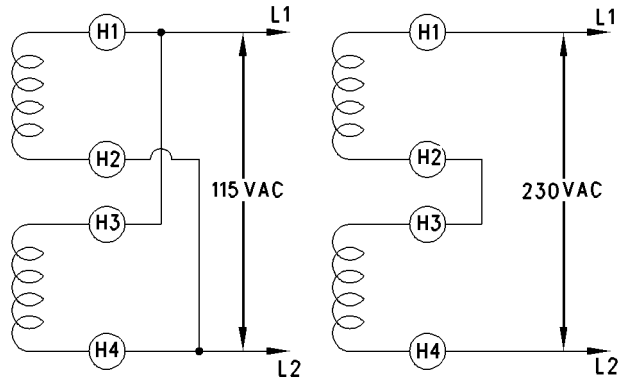


Illustration 103 g00610396

Space Heater Connection Diagram

An SR5 generator can operate in high humidity conditions without problems. The humidity can be as high as 100% no condensing humidity. However, problems can occur when the generator is idle and the surrounding air is warmer than the generator. Moisture can form on the windings. Moisture will result in poor performance or even damage to the windings. Whenever the generator is not active, the optional space heaters should be operated.

An external source is required to operate the space heaters. Both of the sources must be a single phase. This source can be either 115 vac or 230 vac. When the external source is 50 hertz, 200 vac must be used. Refer to Illustration 103.

See your Caterpillar dealer for information on checking your Caterpillar generator.

i01472973

Speed Sensor - Clean/Inspect

SMCS Code: 1907-040; 1907-070

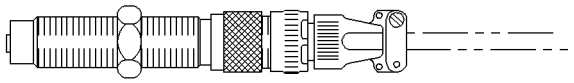


Illustration 104 g00293337

Typical speed sensor

1. Remove the speed sensor from the flywheel housing. Check the condition of the end of the speed sensor. Check for signs of wear and contaminants.

2. Clean the metal shavings and other debris from the face of the magnet.

3. Install the speed sensor according to the information in the Service Manual, “Specifications”.

i01038735

Standby Generator Set Maintenance Recommendations

SMCS Code: 4450-041

A standby generator set may not need to be used very often. However, the generator set is usually needed for operation in an emergency situation. Maintenance of the standby generator set is very important for the following reasons:

- The generator set must always be in excellent operating condition.
- The generator set must be ready to work under load at any time.

Establishing a Preventive Maintenance Program will provide these benefits:

- Maximum availability of the standby generator set
- Longer service life for the generator set
- Minimum of expensive repairs

Your Caterpillar dealer can help you to establish an effective Preventive Maintenance Program for your generator set. Consult your Caterpillar dealer for details.

Maintenance and Operation Procedures

⚠ WARNING

The high voltage that is produced by an operating generator set can cause severe injury or death. Before performing any maintenance or repairs, ensure that the generator will not start.

Place the engine control switch in the “OFF” position. Attach “DO NOT OPERATE” tags to all starting controls. Disconnect the batteries or disable the starting system. Lock out all switchgear and automatic transfer switches that are associated with the generator.

The recommended maintenance for the engine is listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule (Standby Generator Set Engines)” (Maintenance Section).

For the recommended generator maintenance, see the Operation and Maintenance Manual for the generator and the control panel.

Maintenance and Repair

The maintenance that is recommended for Every Week can be performed by an authorized operator. The maintenance that is recommended for the subsequent maintenance intervals must be performed by an authorized service technician or by your Caterpillar dealer.

Unless other instructions are provided, perform maintenance and repairs under the following conditions:

- The engine is stopped.
- The starting system is disabled.
- The generator does not pose an electrical shock hazard.

Operation

To ensure proper operation, the generator set must be exercised regularly. For instructions on operating the generator set, see the Operation and Maintenance Manual for the generator set control panel.

For these operation procedures, follow the instructions that are provided in this Operation and Maintenance Manual, “Operation Section”: starting the engine, engine operation, and stopping the engine.

Record Keeping

Maintain a record in order to document these items: gauge readings, maintenance that is performed, problems, and repairs.

Space Heaters

Moisture causes damage to generators and other electrical equipment. Make every effort to keep the generator set as dry as possible.

Generators can operate without problems in humid environments. However, problems can occur when the generator is inactive. Moisture can condense on the windings. This can result in poor performance. Also, damage to the windings can occur.

Use space heaters in order to help keep the windings dry. When the generator is not active, ensure that the space heaters are operating. When the generator is operating, turn OFF the space heaters.

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i03230840

Stator Lead - Check

SMCS Code: 4459-535

Ensure that the stator output leads are routed out of the generator in a manner that prevents the leads from rubbing against metal objects.

Visually inspect the following areas for cracking and physical damage:

- stator output leads
- protective sleeving
- insulation

i03725200

Stator Winding Temperature - Test

SMCS Code: 4453-081-TA

Some generators are provided with optional 100 Ohm Resistance Temperature Detectors (RTD). When the temperature of the stator winding is suspected to be high, measure the temperature. If the generator is furnished with Resistance Temperature Detectors, the detectors are installed in the slots of the main armature (stator). The detectors are used with equipment that is available from the factory. This equipment is used in order to measure the main armature's winding temperature.

i01539769

Turbocharger - Inspect

SMCS Code: 1052-040

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE
Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

   The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.

5. Inspect the bore of the turbine housing for corrosion.

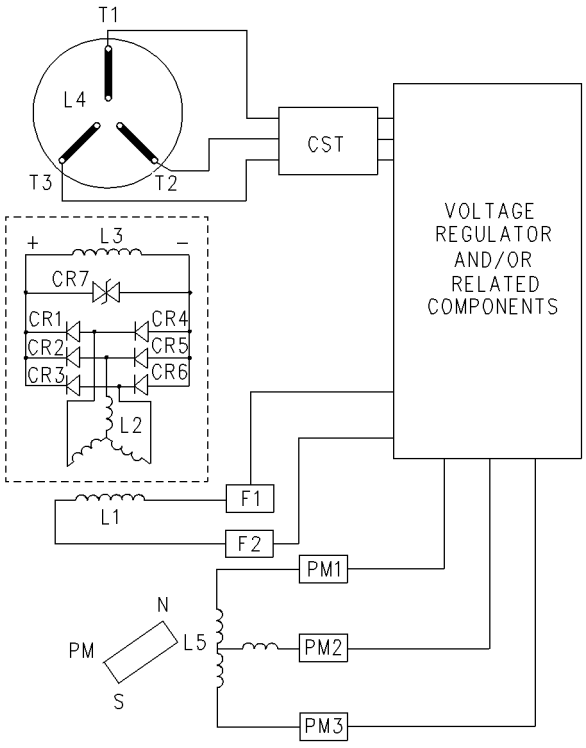
6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.

7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i01494879

Varistor - Test

SMCS Code: 4466-081



g00677004

Illustration 105

PMPE Generator Wiring Diagram

(CR1-CR6) Diodes
(CR7) Varistor
(L1) Exciter field (stator)
(L2) Exciter armature (rotor)
(L3) Main field (rotor)
(L4) Main armature (stator)
(L5) Pilot exciter armature
(PM) Permanent magnet
(RFA) Rotating field assembly
(CST) Customer supplied transformer

Ohmmeter

An ohmmeter can be used to check a varistor (CR7). Place an ohmmeter across the varistor. The resistance should be a minimum of 15000 ohms. If the resistance is less than 15000 ohms, the varistor is faulty.

Test Light

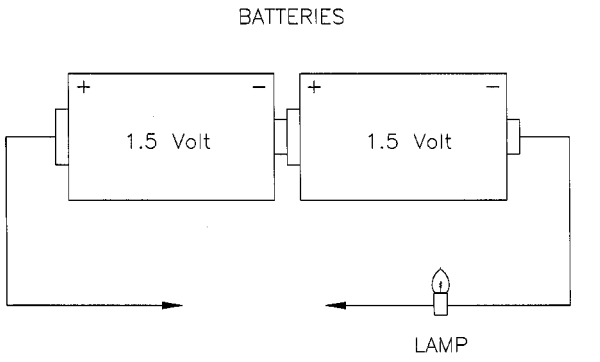


Illustration 106 g00555113
Test Light

Refer to the test light that is shown in Illustration 106. Follow these steps in order to test the varistor:

1. Disconnect either lead of the varistor (CR7).

2. Place the test light across the varistor.

3. Observe the results. The lamp should not light.

4. Reverse the test light.

5. Observe the results. The lamp should not light.

If the test light illuminates in either direction, there is a short in the varistor. Replace any faulty varistors with varistors that have comparable operating characteristics. Include the following information when a varistor is being ordered for replacement:

- Part number of the varistor
- Serial number of the generator

After the varistor has been replaced, verify that the strapping of the field winding lead is securely wound on the shaft. Also, verify that the strapping of the field winding lead is securely tied.

i01189996

Voltage and Frequency - Check

SMCS Code: 4450-535-EL

Check for proper voltage and frequency setting. Check for stability.

Refer to the generator set Serial Plate for correct voltage and frequency.

i02591373

Walk-Around Inspection

SMCS Code: 1000-040

⚠ WARNING

Personal injury or death can result from improper troubleshooting and repair procedures.

The following troubleshooting and repair procedures should only be performed by qualified personnel familiar with this equipment.

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE
For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE
Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that cooling lines are properly clamped. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pump and the installation of water pump and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the Closed Crankcase Ventilation (CCV) filter, if equipped. If the restriction indicator is visible, service the CCV.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the engine-to-frame ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauges that can not be calibrated.

Inspect the Generator

Refer to Safety Section, “Generator Isolating for Maintenance” for information regarding the procedure to safely isolate the generator.

A visual inspection should be initially directed at the areas that are most prone to damage and deterioration. The most prone areas to damage and deterioration are listed below:

Ground insulation – Ground insulation is insulation that is intended to isolate components that are carrying current from components that are not carrying current.

Support insulation – Support insulation is usually made from one of the following items: a compressed lamination of fibrous materials, polyester, or felt pads that have been impregnated with various types of bonding agents.

There are many different types of damage that can occur in these areas. Several of the different types of damage are listed below:

Thermal aging – Thermal aging can cause the degradation of insulation or the deterioration of insulation. An examination of the coils may reveal that the insulation has expanded into the ventilation ducts. This is the result of a loss of bond which will cause the insulation material to separate. The insulation material could also separate from the conductors on the windings.

Abrasion – The surfaces of coils and the surfaces of connectors may be damaged by abrasion. These surfaces may also be damaged by contamination from other sources. An example of these sources would be chemicals or abrasive substances.

Cracking – Cracking of insulation may result from mechanical stress. The structure that is used to brace the stator winding will become loose if the problem is not corrected. Further mechanical damage or electrical damage may also result.

Erosion – Erosion can be caused when foreign substances rub against the insulation that is on the surface of the coil .

i03543200

Water Pump - Inspect

SMCS Code: 1361-040

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

A failed water pump might cause severe engine overheating problems that could result in cracks in the cylinder head, a piston seizure or other potential damage to the engine.

Visually inspect the water pump for leaks. If leaking of the water pump seals is observed, replace all of the water pump seals. Refer to two articles in the Disassembly and Assembly Manual, “Water Pump - Disassemble and Water Pump - Assemble” for the disassembly and assembly procedure. If it is necessary to remove the water pump, refer to two articles in the Disassembly and Assembly Manual, “Water Pump - Remove and Water Pump - Install”.

Inspect the water pump for wear, cracks, pin holes and proper operation. Refer to the Parts Manual for the correct part numbers for your engine or consult your Caterpillar dealer if repair is needed or replacement is needed.